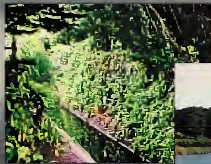
Lake Merced Technical Memorandum No. 2



Vista Grande Diversion Feasibility Evaluation

Prepared for

City and County of San Francisco
City of Daly City
nty of San Mateo

2001

by
and The Duffey Company

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Introduction

Summary

The Vista Grande Diversion Feasibility Evaluation Project is being conducted jointly by the City and County of San Francisco (CCSF), the City of Daly City (Daly City), and San Mateo County to assess the feasibility of diverting treated storm water from the Vista Grande Canal (Vista Grande) to Lake Merced (Figure 1). This potential diversion could provide dual benefits of reducing the canal's recurring flooding problems and providing a moderately reliable supply of water to increase the level of Lake Merced.

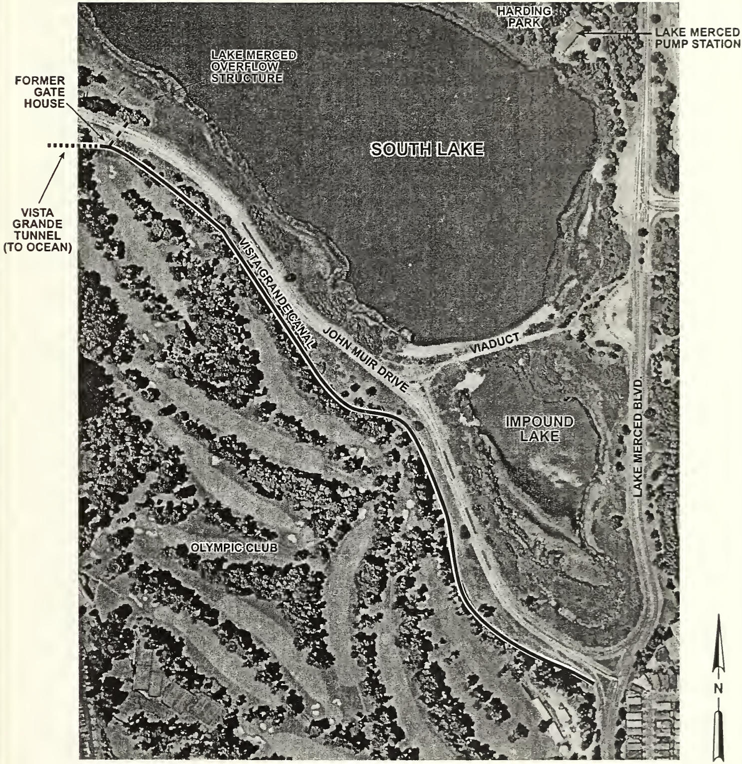
The first phase of the Feasibility Evaluation – summary of issues followed by identification, evaluation, and screening of alternative approaches – indicates that no single alternative will address all of the project objectives. The top ranked alternatives were Structural Control Measures and Constructed Wetlands.

Extensive water quality sampling of Vista Grande storm water conducted during the winter of 2000 to clarify uncertainties regarding the coliform levels in the storm water indicated that levels were very high relative to those in Lake Merced. The coliform levels varied significantly and did not have a discernible pattern of occurrence. During the development of the conceptual design, it was assumed that Daly City would identify the source of the coliform in its storm water through an intensive investigation during the initial rainfall events of the 2001 water year and that design and construction of the pilot project would occur during the fall of 2001.

The second phase of the project – development of the conceptual design for full-scale stormwater diversion – involves installation of structural control units and new conveyance structures with development of natural treatment wetlands along the south shore of South Lake and around Impound Lake. These facilities will transport and provide treatment to storm water from the Vista Grande Canal, if the source of coliform in Daly City's storm water stream can be identified and corrected. Pilot testing of this alternative is planned for January 2002. The pilot test will consist of evaluating the treatment capabilities of the structural control unit and, if water quality allows, using the existing Lake Merced Overflow Structure to test stormwater conveyance.

Background

This section discusses the relevant issues for Lake Merced, Vista Grande, and the project participants. Existing documents have been used as much as possible to provide the background information. Photographs of many of the structures and areas discussed in this report are included in Attachment A.



Base Aerial Photo from CDM.
Photo taken June 10, 1994. South Lake elevation: -3 ft, city datum ($5^1/_2$ ft msl)

Figure 1
Features of the Southern Lake Merced and Vista Grande Area

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Lake Merced

Description and Issues

Lake Merced is a natural water body under the jurisdiction of the San Francisco Public Utilities Commission (SFPUC), which manages the lake as an emergency water supply for firefighting and domestic use[1]. The land and park area immediately surrounding Lake Merced are under the jurisdiction of the San Francisco Recreation and Park Department for recreational use.

Lake Merced is also a significant natural resource for the northern San Francisco peninsula. It provides fresh water habitat to birds and wildlife and recreational opportunities for local residents. Birds are the predominant wildlife species although numerous amphibians, reptiles, and mammals also inhabit the wildlife habitats of the Lake.

In recent years, declining lake levels at Lake Merced have caused concern among local residents, lake users, and citizens committed to preserving plant and animal habitats and recreational opportunities at the lake. There is strong local support for reversing the trend of declining lake levels.

The water level of Lake Merced fluctuates naturally in response to seasonal and annual variations in precipitation, temperature, and local groundwater use. Historically, the annual lake level fluctuation ranges from 1.2 to 5.2 feet. The rate of regression (i.e., the seasonal decline in lake level) has been relatively consistent during the period of record for the elevation of Lake Merced (1928 to present). The overall decline in the lake level since the late 1950s has been attributed to drought, reduction of surface runoff from rainfall entering the lake, and increases in local groundwater pumping (CH2M HILL 1997). Current lake levels are lower than they were in the 1960s and 1970s but are not unprecedented (Figure 2). The low lake levels in the early 1990s were higher than the low lake levels recorded in the 1930s, when the lake was used as a local water supply and before the SFPUC's Hetch Hetchy system began operation.

Before the construction of Crystal Springs Reservoir in 1975, Lake Merced was also used as an informal balancing reservoir for the Hetch Hetchy system; surface water was routinely added to the lake, resulting in artificially maintained high lake levels[2]. The Lake Merced overflow structure, located midway on the southern shore of South Lake, prevented the lake level from rising above 16.8 feet[3,4]. This elevation coincides roughly with the highest recorded levels of Lake Merced, which occurred in 1941 and 1952[5]. The overflow structure was controlled at the 'gate house' (see Figure 1 for location) and empties into Vista Grande

1 Lake water may be pumped into the City supply system through the Lake Merced pump station. Since no permanent disinfection process exists at the pump station, minimum health requirements would consist of a Boil Water Order and an Unsafe Water Alert being issued to all users.

2 Water from the Hetch Hetchy System not provided to wholesale or retail customers would periodically be added to Lake Merced. The CCSF kept no records on how much surface water was added to the lake or how much water from the lake overflowed into the canal. However, review of daily records kept by CCSF indicates periodic increases in lake level when no precipitation was reported, indicating a probable addition of water to the lake.

3 Elevations in this report are in CCSF City Datum, which is 8.616 feet above mean sea level.

4 16.82 is the elevation indicated on Lake Merced Boulevard (John Muir Drive) Extension to Flood Water Control, March 1934, File L-10,466.

5 Historical CCSF documents indicate that Lake Merced overflowed in 1940, 1941, and 1942. Given the recorded lake levels for the remainder of the decade, it is probable that the lake also overflowed during most other years in the early to mid 1940's.

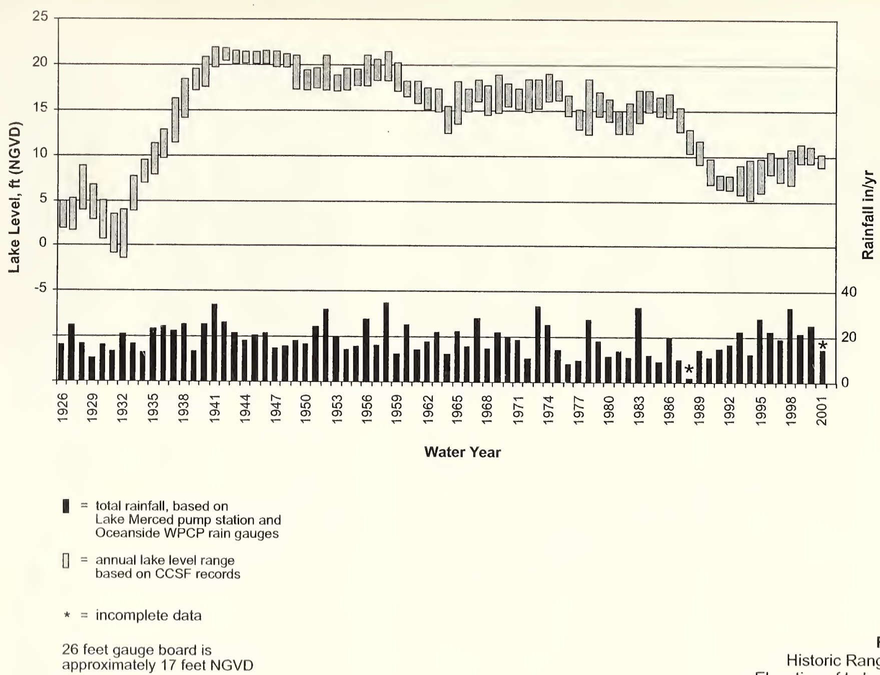

Figure 2
Historic Range of the
Elevation of Lake Merced

W0820010078AC exhibit001-Fig2rev graph fh9

at the entrance to the tunnel. In the spring of 2000, a joint effort between Daly City and CCSF cleared the overflow structure to determine whether it was a possible route by which storm water from Vista Grande could be added to Lake Merced. The overflow structure will be discussed later in this report.

Additional historic changes in the Lake Merced area include the 20th century urbanization of the area. Storm sewers now drain the urbanized area, significantly reducing surface water runoff emptying into Lake Merced. Rainfall that previously ran off the surrounding land into the lake is now diverted to storm sewers and discharged to the Pacific Ocean. Figure 3 shows the reduction in the Lake Merced drainage basin. It is now approximately 10 percent of its pre-development size (CDM 1999). The only surface water runoff entering Lake Merced comes from Harding Park, portions of the Olympic Club, and the roadways and parking lots directly adjacent to Lake Merced.

During the late 1990s, water was added periodically to the lake when it became available from the SFPUC. These periodic additions provided short-term benefits but no sustained increase in the lake level (Figure 4). Water has not been added to the lake consistently for several reasons. There were operational constraints[6] at the Lake Merced Pump Station during the winter of 1997, water addition was restricted to protect waterfowl during the nesting season[7], and supplemental surface water was not available from the SFPUC system.

Lake Merced is part of a complex hydrogeologic system referred to as the Westside Basin. This basin extends from Golden Gate Park to the San Francisco International Airport (Figure 5). Past studies indicate that lake level is integrally related to the groundwater levels in the Westside Basin (Yates et al, 1990; CH2M HILL, 1997). To address common Westside Basin groundwater issues, the basin's potable water users entered into a cooperative agreement and developed an AB 3030 Groundwater Management Plan (Bookman-Edmonston, 1999). In addition, Daly City has been negotiating with the local golf courses to reduce their local groundwater use and to receive tertiary-treated recycled water from Daly City.

Previous Work

The 1998 Draft Lake Merced Comprehensive Management Plan (CMP; SFPUC, 1998) was developed to address declining lake levels and deteriorating conditions at the lake. The Lake Merced CMP identifies actions to be implemented to protect and enhance the lake's beneficial uses. The CMP identified Action WRS-1.4 - Develop and Evaluate Alternatives for Increasing Lake Level. The product of Action WRS-1.4 is the Lake Merced Technical Memorandum No.1 (Tech Memo No. 1), Feasibility Evaluation of Alternatives to Raise Lake Merced (CH2M HILL, 1998).

Tech Memo No. 1 evaluated and ranked a series of options to raise the water level of Lake Merced and maintain it within a specified range. This evaluation determined that

[6] Routine maintenance is performed during the winter months when supply demands are lower. During the winter of 1997, when water could have been available for addition to Lake Merced, the Sunset supply line was undergoing maintenance. Therefore, water could not be added to the lake.

[7] Through a Categorical Exemption effective through 2002, water may not be added from April 15 through July 15. Additions of water to the lake are limited to a rise in lake level of 1 foot between July 15 and February 15 and 0.5 foot between February 15 and April 15.

Watershed Area from CDM

0 3000
feet

N

Legend:

Pre-development Watershed (Approx. 6,320 Acres)

Existing Watershed (Approx. 650 Acres)

Figure 3
Lake Merced Watershed:
Comparison of the 1935 and
1995 Drainage Areas

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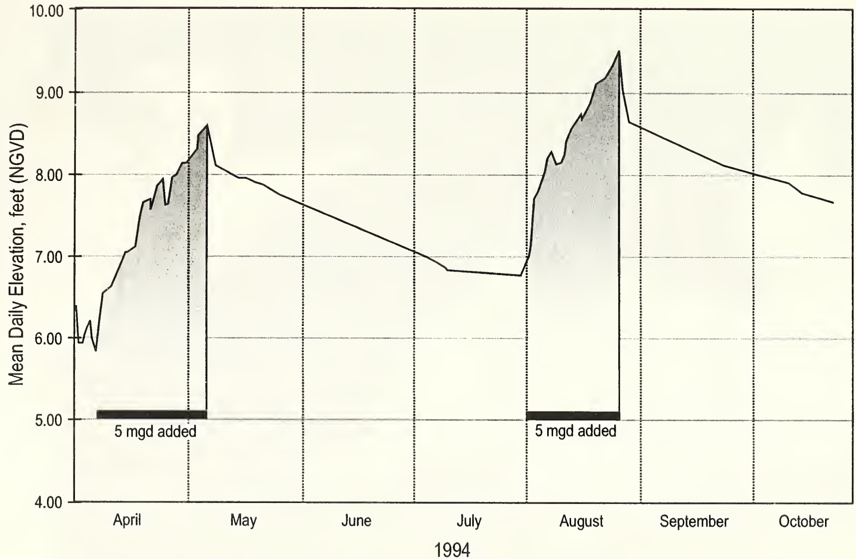

Figure 4
Lake Level Response to 5-mgd Addition of SFPUC Imported Surface Water

DATA SOURCE: USGS Recorder 11162680 Lake Merced at Pumphouse

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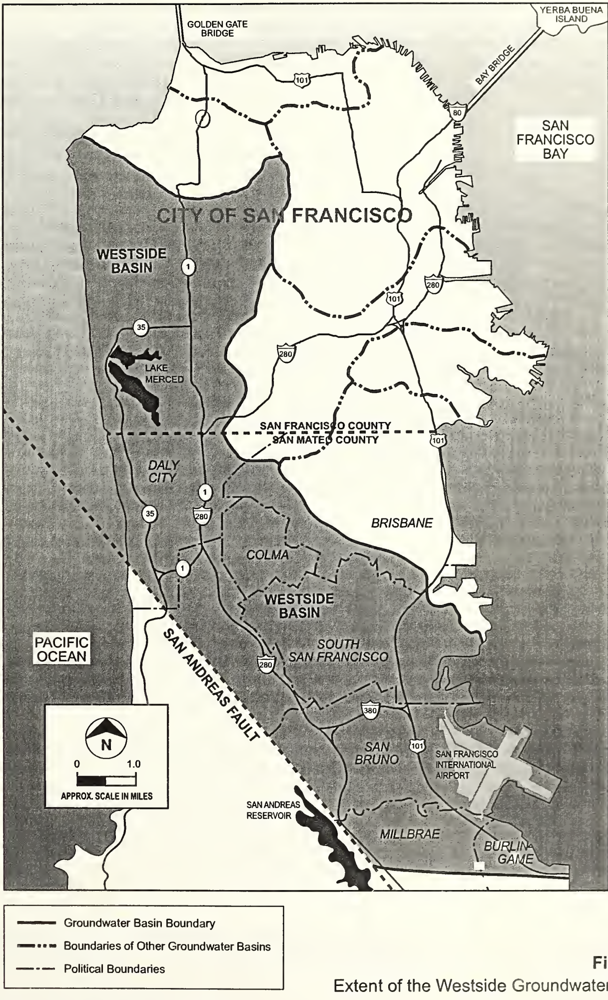

Figure 5
Extent of the Westside Groundwater Basin

from San Francisco Groundwater Master Plan, draft 1996

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increasing recharge by adding water to the lake is the lake water budget component over which the SFPUC has the most control. Adding water to the lake would also provide the most immediate rise in the level of the lake. The report identified the three most feasible options for increasing Lake Merced recharge as:

- Add SFPUC-imported surface water directly to Lake Merced
- Inject recycled water into the aquifer at existing wells
- Divert storm water from Vista Grande to Lake Merced

These options were presented to the SFPUC for consideration. SFPUC Resolution No. 98-0293 (November 24, 1998) authorized staff to obtain approvals for implementation of Alternative No. 7, Diverting Storm Water from Vista Grande Canal to Lake Merced. Within the next 5 years the SFPUC will convert its system-wide disinfecting process to chloramination. Once the conversion occurs, adding water from the Hetch Hetchy system will no longer be an option because chloraminated water can be toxic to aquatic life.

The Lake Merced CMP built upon the Lake Merced Water Resource Planning Study (Geo/Resources, 1993), which addressed the declining lake level. This report recommended several approaches to increase the lake level, including increasing storm water runoff into the lake. The Geo/Resources report also provided a preliminary lake level recommendation of 26 feet, as measured at the Lake Merced Pump Station gauge board[8], and suggested further evaluation of the optimum lake level. Their recommended 26-foot elevation gauge board (approximately 17 feet mean sea level/NGVD and 8.5 feet City datum) was based on requirements for emergency water supply, recreation, and fish and wildlife habitat benefits and demands. The current (October 1, 2001) gauge board elevation of Lake Merced was 16.61 (–0.9 feet and 7.8 msl).

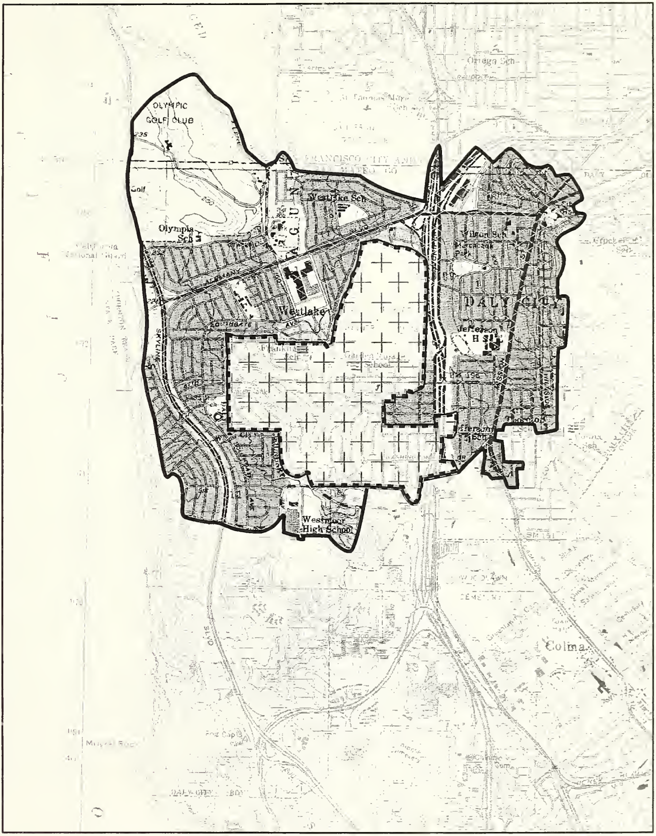
Vista Grande

Description and Issues

Vista Grande is a series of brick-lined open canals and a tunnel that carry storm water from Daly City and part of unincorporated San Mateo County to the ocean outfall below Fort Funston (Figure 6). Vista Grande runs from the intersection of John Muir Drive and Lake Merced Boulevard to the ocean outfall (see Figure 1). Flow in Vista Grande is currently constrained by the size of the tunnel. Storm water from Daly City is conveyed directly to Vista Grande by a series of gravity conduits and concrete box culverts.

The first open canal section of Vista Grande parallels the southwestern shore of Lake Merced (both South and Impound Lakes) for approximately one-half mile. The canal enters the tunnel just south of the Oakwood Apartments. The tunnel conveys storm water beneath the Olympic Club to the ocean outfall one-half mile offshore. Where the canal empties into the tunnel, the secondary effluent from the North San Mateo County Sanitation District (NSMCSD) a subsidiary of the City of Daly City, also enters the tunnel and is conveyed to the ocean outfall. During rainfall events, the NSMCSD bypasses the gravity-feed system to free-up tunnel capacity for stormwater outflow and conveys its effluent through a 27-inch

[8] The gauge board datum is 8.76 feet below mean sea level and 17.5 feet below the CCSF datum. The gauge board was a reference point painted on the wall of the Lake Merced Pump Station. A few years ago it was painted over and is now illegible, but the gauge board continues to be used as a reference for Lake Merced elevations.



Vista Grande Stormwater System Drainage Area Boundary

Daly City

Unincorporated San Mateo County

N

0 3000
feet

Figure 6
Vista GrandeStormwater
Drainage Basin

force main that transverses the Olympic Club to the ocean outfall at Fort Funston Beach. The Lake Merced overflow structure joins the Vista Grande tunnel just inside the upstream tunnel opening, approximately 30 feet downstream of the gravity feed secondary effluent line.

During storm events, flooding sometimes occurs in portions of Daly City, San Mateo County, and along the Vista Grande canal; this is either the direct or indirect result of the limited capacity of the Vista Grande tunnel. Kennedy/Jenks (1983) estimated the tunnel's capacity to be 170 cubic feet per second (cfs). This flow rate is exceeded most years. Limitations in Vista Grande capacity have also hindered Daly City's ability to improve the system upstream and relieve other localized flooding problems in Daly City and the unincorporated portion of San Mateo County served by the Vista Grande storm water system.

When flow rates in Vista Grande exceed 170 cfs for a sustained period, flow within the tunnel reportedly becomes surcharged. During extremely intense storm events excess storm water has flowed across John Muir Drive and directly into the lake. Documented flow across John Muir Drive occurred in January 1998 and January 2001. On both occasions, extensive damage was sustained to John Muir Drive and the shoreline of Lake Merced. Water quality impacts to the lake were not identified. Surcharged flows within the tunnel also present a hazard to the safety of the brick-lined tunnel because of the potential for erosion around the bricks and subsequent collapse (Kennedy/Jenks 1983).

Previous Work

Daly City's evaluation of its storm water sewer system indicated that reducing flooding problems in Daly City, San Mateo County, and along the Vista Grande canal is not possible without reducing the flow in the tunnel (Kennedy/Jenks 1983). Its evaluation of alternatives indicated that the most feasible alternative was to divert storm water to Lake Merced through a series of overflow structures to the lake. It was proposed that each overflow structure have a trash gates at its entrance. No water quality treatment was proposed for these overflow structures. Other alternatives evaluated by Kennedy/Jenks included the construction of a parallel tunnel and the widening of Vista Grande to temporarily detain storm water before discharging it through the existing tunnel.

Kennedy/Jenks also evaluated potential storm flows through Vista Grande for the existing system and for the upstream system improvements proposed by Daly City to relieve localized flooding problems. Once the proposed system improvements are completed, storm water will move through the system more rapidly, resulting in higher peak flows of a shorter duration than the current peak flows. The maximum flow rates and the maximum volume of surcharge at the tunnel entrance for the storm flows modeled by Kennedy/Jenks are summarized in Table 1.

TABLE 1
Estimated Peak Flows and Maximum Surcharge Volumes at Entrance to Vista Grande Tunnel[a]
Vista Grande Diversion Feasibility Study

Evaluated Storm	Current System		With System Improvements	
	Maximum Surcharge Volume (million gallons)	Estimated Peak Flows (cfs)	Maximum Surcharge Volume (million gallons)	Estimated Peak Flows (cfs)
5-year, 4-hour	23.6	635	33.8	1,141
10-year, 4-hour	25.9	677	39.2	1,298
10-year, 6-hour	29.8	614	41.7	1,066
25-year, 4-hour	not analyzed	not analyzed	53.0	1,126

[a] Kennedy/Jenks (1983), based on system hydraulic modeling.

Regarding the feasibility of diverting storm water into Lake Merced by the method described in the Kennedy/Jenks report, the CCSF expressed concern about water quality impacts to the lake (CH2M HILL, 1990). Subsequent miscellaneous communications from the CCSF re-iterated its concerns that diversions of storm water could not occur until there were water quality protections.

Since the release of the Feasibility Evaluation of Alternatives to Raise Lake Merced (SFPUC, 1998), Daly City has measured actual Vista Grande flows (TRS, 1999) and the SFPUC has sampled the quality of the Vista Grande storm water (CDM, 1999 and SFPUC 2000/2001 data). The 1999 Vista Grande Canal measured flow data were consistent with data used earlier in the Kennedy/Jenks report. These water quality data will be discussed in detail in the Water Quality Assessment section.

Project Participants

Three organizations are participating directly in this project: the SFPUC, Daly City, and San Mateo County. Daly City and San Mateo County are seeking approaches to alleviate flooding within their jurisdiction. SFPUC is looking for opportunities to increase inflows to Lake Merced. For each of the groups, diverting storm water back to Lake Merced, if feasible, offers an opportunity to restore part of the former Lake Merced watershed to the lake.

Project Approach

During the Phase 1 of the Feasibility Evaluation, the overall approach to the Vista Grande storm water diversion was evaluated in terms of hydraulics and general impacts to Lake Merced. Potential hydraulic constraints relative to treatment and the ability of the lake to accept quantities of storm water were also considered. Data were assessed to identify possible water quality issues or treatment concerns. Finally, eight approaches to addressing storm water quantity and quality were screened.

These eight options for potential storm water treatment have been identified and evaluated using a matrix approach, which assess performance criteria, siting constraints, environmental and compliance impacts, beneficial uses, capacity, operation and maintenance costs, and construction costs. The top alternatives from this evaluation were recommended for additional evaluation during Phase 2.

Conceptual design for installation of large-scale structural control units and development of natural treatment wetlands is included in this report, as well as discussion for pilot testing the approach using the existing Lake Merced overflow structure. Pilot testing, which will not occur during the Feasibility Evaluation, includes collecting in-field data for the assessment of the full-scale long-term feasibility of the alternative. Additional high-ranked alternatives may be evaluated in subsequent work to be conducted by the SFPUC and Daly City.

Water Quality Assessment

This section summarizes Lake Merced and Vista Grande water quality data and issues and their impact on potential treatment strategies and Lake Merced fish and wildlife habitats.

Water quality issues associated with diverting storm water from Vista Grande to Lake Merced include:

- Water treatment approaches
- Protection of lake quality
- Protection of lake habitat

Conditions cited in this section are based on available Lake Merced water quality data and Daly City storm water quality data collected through spring 2001. Water quality data presented in the Lake Merced Watershed Sanitary Survey (CDM, 1998) and the Lake Merced Water Resource Planning Study (Geo/Resources, 1993) were also reviewed. Additional water quality sampling is planned for Lake Merced, Vista Grande, and within the Daly City system during the early storm events of the 2001/2002 wet weather season. This additional sampling will be conducted to confirm ongoing water quality issues, such as coliform, before final decisions can be made about diverting storm flows into Lake Merced. This sampling program is discussed in the Pilot Testing portion of this report.

General Overview of Storm Water Constituents

Constituents of concern generally found in urban storm water systems are variable and influenced by activities within the drainage area. Constituents of concern often include the following (Woodward-Clyde, 1998):

- Total Suspended Solids (TSS)
- Total Nitrogen
- Total Phosphorus
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Silver
- Zinc
- Chlordane
- Chlorpyrifos
- Diazinon
- Malathion
- Total DDT
- Total Polynuclear Aromatic Hydrocarbons (PAHs)
- Total Polychlorinated Biphenyls (PCB)
- Selenium
- Simazine

In addition to those listed above, constituents of concern for mass emission monitoring are:

- Bacteria
- Total Phenols
- TPH
- Oil and Grease
- Cyanide

Summary of Available Water Quality Data

Historic water quality data from both Vista Grande and Lake Merced provide information regarding compatibility of the waters, ranges of pertinent water quality parameters, and water treatment issues to be considered during this feasibility evaluation. Table 3 summarizes available water quality data from Lake Merced and Vista Grande. Table 4 summarizes water quality data collected during the 2000-2001 wet weather season. Data have been collected for a wide range of parameters in the lake and the canal. Figure 7 summarizes the canal, lake, and drainage basin sampling locations.

Vista Grande Canal

Water quality data have been collected periodically by Daly City and more recently in a focused program conducted jointly by the SFPUC and Daly City. The Daly City data are reported to be from the Vista Grande canal, just west of Lake Merced Boulevard (Geo/Resources, 1993). The SFPUC data were collected in the canal just south of Lake Merced at the mouth of the ocean outfall tunnel. Water quality data were also collected from a storm drain in the Daly City Wastewater Treatment Plant parking lot and from a storm drain collecting surface runoff from the Olympic Club. In this analysis, it is assumed that the data collected from the Vista Grande Canal provide the best information on the current overall quality of the storm water that could be diverted to Lake Merced.

Lake Merced

Two types of data are collected by the CCSF regarding Lake Merced water quality and lake conditions. The SFPUC collects water quality data from Lake Merced weekly as a part of its systemwide reservoir assessment. Limnologic data are collected quarterly to assess changes in lake clarity and general conditions.

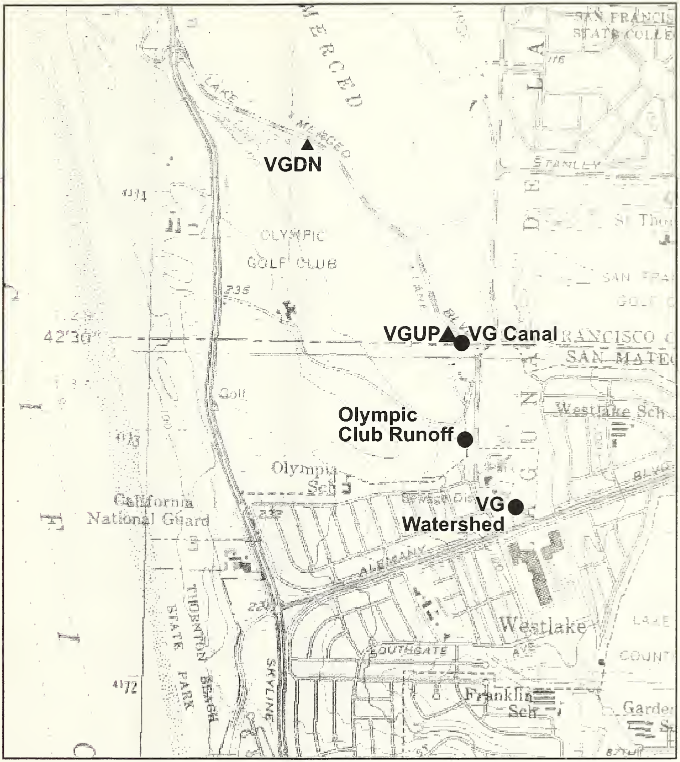
Lake Merced Drainage Basin

The SFPUC, with support from Daly City, has conducted storm water sampling at several locations within the Lake Merced and Vista Grande drainage areas to characterize water quality conditions.

Key Water Quality Parameters for Treatment

The general approach to assessing the need to treat storm water diverted from Vista Grande to Lake Merced is to determine whether that storm water meets or exceeds, where possible and reasonable, the existing quality of the lake. Protection of the lake's water quality and the wildlife habitats it supports is a crucial component of the future implementation of the proposed alternatives.

The Lake Merced Sanitary Survey (CDM, 1999) specified applicable water quality parameters for the identified beneficial uses of Lake Merced (designated by an 'x' in Table 5). The proposed alternatives provide a variety of potential water quality treatments, ranging from none to extensive.



▲ Vista Grande Sampling Location

● Drainage System Sampling Location

N

0 1000 feet

Figure 7
2000-2001 Water Quality
Sampling Locations

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TABLE 3
Summary of Vista Grande and Lake Merced Water Quality Data
Vista Grande Diversion Feasibility Study

Water Quality Parameter	Units	MCL's[a]	Lake Merced Water Quality				Vista Grande Storm Water[d]		
			1993 Study[b]	1997 Average[c]	1997[c] Range	2000-2001 Range	1984 Average	1998-2000 Range	2000-2001 Range
BOD	mg/l	--	--	--	--	<5	--	--	<5-49
COD	mg/L	--	--	--	--	--	--	22-994	15-3150
Dissolved Oxygen	mg/l	--	6.5	9.3	6.8-12.4	--	7.8	--	--
Conductivity	µmhos	900 (S)	765	819	767-874	555-867	56	--	--
pH	Unit	--	8.7	8.6	8.2-9.1	7.97-9.02	7	--	--
Temperature	°C	--	14.5	18	13.3-24.4	--	15.5	--	--
Total Dissolved Solids (TDS)	mg/L	500 (S)	472	--	--	330	41.5	--	--
Total Suspended Solids (TSS)	mg/L	--	13	--	--	--	44.5	5-498	1-564
Turbidity	NTU	0.5 (P)	13.2	16	3.4-32	7-35	22.5	--	--
Alkalinity	mg/L	--	229	281	256-312	74-334	16	--	14-112
Hardness	mg/L	--	247	273	258-288	188-296	38	--	17.8-184.8
Total Coliform	MPN/100mL	Absent (P)	305	1450	8-16,000	200-5,200	220,000	--	5,210->241,920
Oil and Grease	mg/L	--	1.3	--	--	--	3.0	5-93	0-204
Color	Unit	15 (S)	26	--	--	<5-277	--	--	--
Algae	No/cuM	--	--	$8.3x10^8$	$2.9x10^8$-$1.3x10^9$	--	--	--	--
Nitrogen (total as N)	mg/L	10 (P)	0.1	<0.09	<0.09	<.00002	--	--	0.6-3.96[e]
Phosphate	mg/l	--	0.031	<0.02	<0.02-0.04	<.07	--	--	0-1.67
Total Kjeldahl Nitrogen (TKN)	mg/L	--	--	--	--	--	--	6.5-7.8	2.5-11.4
Total Organic Carbon (TOC)	mg/L	--	--	--	--	--	--	10.94-87.63	19.06-81.9
Chlorides	mg/L	250 (S)	102	93	88-102	36-270	5.2	--	--
Sodium	mg/L	--	76	--	--	55	4.2	--	--
Arsenic	mg/L	0.05	--	--	--	<.002	--	<0.024-0.039	<.02
Cadmium	mg/L	0.005	--	--	--	<.001	--	<0.002-0.019	<.01
Chromium	mg/l	0.1	--	--	--	<.002	--	<0.002-0.038	<.02
Copper	mg/L	1.3 (AL)	0.002	--	--	<.002	0.012	0.01-0.90	<.02
Lead	mg/L	0.015 (AL)	0.003	--	--	<.002	0.046	<0.022-0.114	<.02
Nickel	mg/L	0.1	--	--	--	<.003	--	<0.007-0.11	<.03
Silver	mg/L	0.05	--	--	--	<.001	--	<0.007-0.055	0.03
Zinc	mg/L	5 (S)	0.001	--	--	<.005	0.10	0.05-0.43	<.05

[a] Maximum Contaminant Levels: P=primary, S=secondary, AL=Action Level. Data (excluding 1998-99 storm water) compiled by CDM, 1999.

[b] Lake Merced: San Francisco Water Department monthly monitoring of South Lake; average for years 1991 to 1992 and annual monitoring for years 1989 to 1991 from Geo/Resource Consultants, Inc. (1993).

[c] 1997 South Lake concentrations from Laboratory Section weekly surface sampling information and Environmental and Field Services Section surface sampling from quarterly limnological profiles of lake.

[d] Copper and zinc concentrations from 1998 sampling of Vista Grande at Lake Merced Boulevard by City of Daly City. Other concentrations obtained in 1984 by Kennedy/Jenks Engineers.

[e] As nitrate (NO_3)

Shaded water quality parameters are identified as constituents of concern

TABLE 4

Summary of Vista Grande, Lake Merced, and Drainage Basin 2000-2001 Water Quality Data

Vista Grande Diversion Feasibility Study

		Sampling Date	10/26/2000	10/30/2000	11/21/2000	11/29/2000	12/12/2000	01/08/2000	01/09/2001	01/10/2001	01/10/2001	01/11/2001	01/23/2001	01/25/2001	02/12/2001	2/19/01 AM	2/19/01 PM	02/20/2001	02/21/2001	02/22/2001	03/05/2001
		Sampling Time	11:00-11:35	9:55-10:03	12:01-12:21	9:48-10:12	9:15-9:30	9:20-9:40	14:00-14:25	8:30-8:45	17:00-17:26	7:35-7:45		14:20-14:55	9:15-9:42	15:47-16:24	7:59-8:36	7:59-8:36	9:01-9:43	8:30-9:48	9:32-9:59
		Notes			1	1, 6, 8, 10	1	1, 5, 8	1	1	1, 2	1, 3	1, 9	7, 8,9	1, 6	1, 7	1	1	1, 7	1	1
		Canal Depth VGUP/VGDN (feet)	Not measured	Not measured	1.5/2.0	1.5/1.5	1.5/1.0	1.5/1.5	1.0/<1.0	4.0/3.0	1.5/1.75	1.0/<1.0	1.0/1.5	Not measured	1.0/1.5	1.5/2.0	4.0/3.5	2.0/1.5	1.5/1.0	2.0/1.0	1.0/1.5
		Pumps On?	Unknown	Unknown	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unknown	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LAKE MERCED AND VISTA GRANDE SAMPLING RESULTS	Toxicity	VGUP				80/90 : N/A		20/30 : N/A						90/80 : 100/100					90/100: 100/100		
		VGUP rep																	100/95		
		VGDN				60/60: N/A		20/70 : N/A											80/90 : 100/100		
		VGDN rep											0						100/95		
		IMPOUND												100/100 : 100/100					100/100 : 100/100		
		IMPOUND rep																	100/100		
		SOUTH												100/100 : 100/100					100/100 : 100/90		
		SOUTH rep																	100/100		
	BOD	VGUP	16.15	44.00	10.10	<5.0	11.20	6.45	6.80	8.85	<5.0/<5.0	<5.05	6.40	N/A	<5.33/<5.0	<5.0	<5.0	<5.0	<5.0	<5.0/<5.0	<5.0
		VGDN	21.10	49.00	11.50	<5.0	12.30	7.20	13.80	7.50	11.55	11.40	18.6	N/A	7.90	20.00	5.00	13.50	15.50	24/25	<5.0
		IMPOUND						N/A						N/A	<5.0	<5.0	<5.0	<5.0	5.00	<5.0/<5.0	<5.0
		SOUTH						N/A						N/A	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0/<5.0	<5.0
	Total Coliform (MPN)	VGUP	>2,419	>2,418	120,300	241,800	45,700	98,040	241,920	155,310	77,010	66,670/54,750	111,990	N/A	198,600/<100	N/A	21,900	86,600	86,640	64,880	155,310
		VGDN	>2,419	>2,418	88,000	>241,900	8,400	141,360	27,550	111,990	5,210	4,650/2,590	>241,920	N/A	241,900	N/A	16,700	>241,900	9,070	12,010	241,920
		IMPOUND						N/A						N/A	1,500	N/A	1,800	1,800	310	5,200	400
		SOUTH						N/A						N/A	4,700	N/A	2,100	1,100	630	730	200
	E. coli (MPN)	VGUP	1,986	>2,419	3,700	7,100	12,000	5,400	27,200	8,800	2,300	2,130	1,750	N/A	4000/<100	N/A	2,500	3,900	5,470	2,280	24,610
		VGDN	>2,419	270	5,300	21,400	200	5,400	4,950	4,720	850	100	>241,920	N/A	61,300	N/A	2,700	104,600	1,100	1,090	27,550
		IMPOUND						N/A						N/A	200	N/A	1,300	900	100	3,090	100
		SOUTH						N/A						N/A	<100	N/A	200	<100	100	310	<100
DRAINAGE BASIN SAMPLING RESULTS[11]	PAHS	Olympic Club Runoff	ND									ND	ND		ND						
		VG Watershed	ND	ND				ND				0.120	ND		ND						
		VG Canal				ND	ND	ND				ND						ND			ND
	Alkalinity	Olympic Club Runoff	92.8									41.6	30.6		84						
		VG Watershed	27.2	25				20				34.8	26.6		16						
		VG Canal				42.8		14				41.6						68			60.4
	Ammonia	Olympic Club Runoff	1.9									0.8			1.63						
		VG Watershed	1.6	0.7				0.9				0.7			1.39						
		VG Canal				0.73		1.2				0.5						0.22			0.22
	COD	Olympic Club Runoff	141									206	35		146						
		VG Watershed	46	105				17					51		43						
		VG Canal				110	16	26										230			62
	TSS	Olympic Club Runoff	38									370	11		210						
		VG Watershed	12	170				11					22		72						
		VG Canal				74	25	36										564			81
	Hardness	Olympic Club Runoff	100.4									105.6	66.4		136						
		VG Watershed	36.8	17.8								52	58		28						
		VG Canal				71.6	184.8					81.6						100			
	MTBE	Olympic Club Runoff																			
		VG Watershed		ND					ND			ND			ND						
		VG Canal				ND	ND		ND			ND							ND		
	NO3	Olympic Club Runoff										2.79	0.6		3.96						
		VG Watershed						0.58				1.08	0.88		0.63						
		VG Canal				1.01		1.23				1.2						1.24			2.14
	NPDES Metals	Olympic Club Runoff																			
		VG Watershed																			
		VG Canal																			
	Total Phosphorous	Olympic Club Runoff	0.44									0.18			0.75						
		VG Watershed	0	0.44				0				0.78	0		0.05						
		VG Canal				0	0	0				0						0			0.04
	TKN	Olympic Club Runoff	4.9									3.4	3.7								
		VG Watershed	2.8	4.1				5				2.5			8.6						
		VG Canal				8.1	3.8	3				2.8						7.6			11.4
	TOC	Olympic Club Runoff	44.1									16.51	19.5								
		VG Watershed	23	9.29				15.33				14.87	13.1								
		VG Canal				24.39	38.72	19.06				32.36									
	TROG_AG	Olympic Club Runoff	0									24	3		5.2						
		VG Watershed	36	12				22				10	11		3.6						
		VG Canal				16	21	14				18						0			0.4

Notes:

1 Request coliform dilution ratio of 100:1 (instead of standard 10:1).
2 Upstream duplicate BOD sample collected. Date reported efter slash is replicate value.
3 Upstream end downstream duplicate coliform sample collected. Data reported after slash is replicete value.
4 Upstream abnd downstream duplicate BOD sample collected. Data reported efter slash is replicate value.
5 Additionel semi-volatile analysis all ND.
6 Upstreem blank collected. Data reported efter slash is blenk value.
7 Analyte holding time exceeded
8 Toxicity includes 2 reps of rainbow trout end lerval fathead minnows (TROUT:MINNOWS).
9 Replicate for VGDN toxicity was trout toxicity only.
10 Downstream sample had very soft (low hardness value) water. Two hardness control samples reflect 100/60 survival rate.
11 Results for additional sampling conducted by SFPUC is not included here, but is included in the ranges provided on Table 3

VGUP= Upstream sample location along Vista Grende Cenel
VGDN= Downstream sample location along Vista Grande Canal
N/A = Not Analyzed
units in mg/L, except where shown

Date from SCA Environmental in letter to Michele Bellows, The Duffey Company, dated April 25, 2001

TABLE 5
Water Quality Parameters for Identified Lake Merced Beneficial Uses[a]
Vista Grande Diversion Feasibility Study

Quality Parameter[b]	Emergency Municipal Supply	Regional Recreation Resource	Natural Resource and Education
PH	X	X	X
Temperature		X	X
Turbidity	X	X	X
Dissolved Oxygen			X
Fecal Coliform	X	X	
Total Coliform	X	X	
Algae (Chlorophyll a)	X	X	X
Color	X	X	
Taste/Odor	X	X	X
Conductivity			X
TDS			X
Suspended Sediments		X	
Alkalinity			X
Nitrogen	X	X	X
Phosphorus	X	X	X
Metals	X		X
Pesticides/Herbicides	X		X
TOC	X		
Oil and Grease		X	
Hardness			
Chlorides			
MTBE[c]	X	X	

[a] From CDM (1999)

[b] Parameters Parameters currently monitored by the Laboratory or Environmental and Field Services Sections of the Water Quality Bureau.

[c] MTBE = methyl tertiary butyl ether

Key Water Quality Parameters for Lake and Habitat Protection

Constituents of Concern

Constituents of concern identified in Vista Grande and Lake Merced (highlighted in Table 3) are common to urban watersheds. The constituents include total recoverable oil and grease, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS) and total phosphorous. Cyanide and phenol levels were also measured but were below the detection limit. Oil and grease contaminants include organic

compounds with different chemical, physical, and toxicological properties. COD and BOD provide an indication of the upstream influences on water quality. Higher COD levels often indicate more industrial influences and higher BOD concentrations occur where there are more municipal or agricultural contributions. TSS can reduce light transmission in lake systems and settle out onto the lake bottom. Elevated concentrations of TSS can affect impact fish populations in aquatic systems.

Metals (arsenic, mercury, cadmium, chromium, copper, lead, nickel, silver, and zinc) in storm water can be associated with natural processes, including chemical weathering and soil leaching, as well as human activities, such as manufacturing. Some metals can be toxic to humans, fish, and wildlife in certain concentrations. Most metals analyzed in the Vista Grande samples were below detection levels. However, chromium, copper, lead, nickel, and zinc were detected in some samples at concentrations near the drinking water maximum contaminant levels (MCLs). These metals will require additional evaluation.

The only organic contaminant found above detection level in Vista Grande during the sampling and analysis for organic compounds in the 1999 to 2000 sampling events was bis-(2-ethylhexyl)-phthalate (EPA 625 contaminant). It occurred at levels ranging from 1.19 (the detection limit) to 3.97 mg/L. This compound is commonly detected as a laboratory contaminant.

The available storm water quality data for Vista Grande indicate that treatment may be required for the following water quality parameters before diversion to Lake Merced.

- Oil and Grease
- Total Coliform
- TSS
- Selected Metals
- BOD/COD
- Total Phosphorous

Also, because Lake Merced appears to be eutrophic (based on initial review of limited limnological data), Vista Grande storm water may need treatment for nutrients before it is diverted to the lake. Treatment requirements will depend on several factors outside the scope of this phase of work and should include characterization of lake hydrology, lake bathymetry, and nutrient speciation in the influent and lake waters. Additional water quality data are needed to better characterize the existing water quality of the lake and canal. Once the initial 2001-2002 wet weather sampling occurs, the pollutant loads for the pilot tested treatment systems can be quantified. The "first flush" phenomenon and the association of metals with particulates in Vista Grande storm water will be needed to finalize the treatment requirements for diversion of Vista Grande storm water to Lake Merced. These concepts are introduced in the next subsection.

Correlation Between TSS and Metals

Elevated levels of chromium, copper, lead, nickel, and zinc were detected in some samples. An analysis correlating TSS and chromium, copper, lead, and zinc are presented in Table 6. The correlation between the metals and TSS does not necessarily mean that these metals are present in particulate forms associated with suspended sediments. Rather, the results indicate that TSS and the analyzed metals are correlated with storm water runoff. However,

river transport of metals is generally characterized by high proportions of particulates, especially during high flows (Elder, 1988). It is probably that project treatment design features that trap suspended sediments will beneficially impact metals water quality.

TABLE 6
Correlation Between Metals and TSS Concentrations in Stormwater Runoff
Vista Grande Diversion Feasibility Study

Metal	Correlation Coefficient with TSS
Chromium	0.58
Copper	0.77
Lead	0.87
Zinc	0.77

The following sections describe specific water quality issues that will drive the final selection of treatment alternatives as this project progresses.

Lake Water Quality Issues

Water quality in lakes is subject to the natural degradation processes of eutrophication and anthropogenic effects. Anthropogenic effects, or human activity, can greatly increase eutrophication rates. Enhanced organic material, BOD, and oxygen deficit also are characteristics of eutrophication. Oxygen-related factors are coupled to eutrophication and temperature as secondary effects of nutrient enrichment and physical mixing characteristics of the water body.

Small lakes are sometimes heavily polluted, and dissolved-oxygen (DO) levels may drop to low values. Removal of the organic inputs may improve lake conditions. However, eutrophic conditions are often slow to change because nutrients are recycled from existing lake sediments. For example, algae or aquatic plants assimilate phosphorus and nitrogen added to a lake. When the organisms die, the bulk of these nutrients are released and become available for assimilation by new cells. Thus, nutrients accumulate in the system (Tchobanoglous and Schroeder, 1987).

When temperature-induced stratification occurs in a lake, the dissolved oxygen concentrations likely will be depleted in deeper water because of algal growth, bacterial activity, and the oxygen demands of the bottom muds (Tchobanoglous and Schroeder, 1987).

Eutrophication may be stimulated by elevated phosphorus or nitrogen inputs, anoxic lake bottom conditions, and/or low lake water clarity. Existing data indicate that each of these conditions may be present at Lake Merced. Existing total phosphorus data need additional review and evaluation to confirm conditions. Anoxic lake bottom conditions are suspected and blue-green algal blooms have occurred at Lake Merced. Secchi depth (a measure of water clarity) is only 1 foot.

Review of available Vista Grande and Lake Merced water quality data indicate that Vista Grande water is equal to or better than Lake Merced water quality for most constituents. However, as discussed above, if further degradation of the lake water quality is to be avoided, nutrient inputs and levels other constituents of concern should be carefully controlled.

Habitat Quality Issues

Lakes and reservoirs contain a variety of living organisms ranging from bacteria to large fish. Usually, the categories of phytoplankton, zooplankton, small fish, and large fish are used to identify these organisms. Bottom-dwelling plants and animals (such as insects and crustaceans) are also present. Phytoplankton and bacteria growth result from the availability of organics and nutrients in the case of bacteria and of nutrients. However, growth of phytoplankton and bacteria occur naturally in most lakes. Potentially pathogenic bacteria (such as fecal coliform) introduced by birds, pets, and sewage leaks decay in exposure to ultraviolet light and oxygenated lake conditions.

In lakes, the predominant phytoplankton species are photosynthetic; they consist of blue and green algae. Consequently, the phytoplankton populations tend to concentrate at the surface. Major parameters in predicting phytoplankton concentration are sunlight time (season, cloudiness), temperature, and turbidity. Because turbidity increases with phytoplankton growth, a form of negative feedback limits growth in highly eutrophic lakes (Tchobanoglous and Schroeder, 1987).

RWQCB Issues

Background

Lake Merced is located within the San Francisco Bay Basin (Region 2) and is regulated by the California Water Quality Control Board (RWQCB), San Francisco Bay Region. The RWQCB has adopted a Water Quality Control Plan[9] that defines the beneficial uses of water bodies in the region. Lake Merced is located within the San Mateo Coastal Basin.

Lake Merced's existing beneficial uses include:

- Cold fresh water habitat (supports cold water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates)
- Warm fresh water habitat (water supports warm water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates)
- Fish spawning (water supports high quality aquatic habitats suitable for reproduction and early development of fish)
- Water contact recreation (water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible)
- Noncontact water recreation (water for community, military, or individual water supply systems, including, but not limited to, drinking water supply)

Lake Merced's potential beneficial use, as defined by the RWQCB, is municipal and domestic water supply. However, no existing mechanism is in place to treat the lake water for drinking water use. Historically, Lake Merced has not been managed as a potable water supply but as an alternative water resource to be used during an emergency, primarily for fire and sanitary control and secondarily for potable use. Under the Surface Water Treatment Rule, Lake Merced could not be considered potable unless the water were filtered and disinfected.[10]

The RWQCB is responsible for Surface Water Protection and Management of the water bodies in the region. Point source discharges to surface waters are generally controlled through Waste Discharge Requirements (WDRs) issued through National Pollutant Discharge Elimination System (NPDES) permits. Storm water is legally considered a point

[9] Water Quality Control Plan, June 21, 1995. Adopted by the California State Water Resources Control Board on July 20, 1995, and by the California State Office of Administrative Law on November 13, 1995.

[10] The California Department of Health Services allows alternative water sources to be used for emergency water sources if they are disinfected and their distribution is accompanied by a Boil Water Order or Unsafe Water Alert.

source,[11] but the RWQCB addresses storm water as a nonpoint source, because water entering the system is generated from diffuse sources.

Under the State's Porter Cologne Water Quality Control Act, any entity discharging waste within the region that could affect the waters of the State is required to file a Report of Waste Discharge (ROWD). The RWQCB reviews the nature of the proposed discharge and adopts WDRs to protect the beneficial uses of the waters of the state. The RWQCB may waive the requirements for filing a ROWD or issuing WDRs for a specific discharge where such a waiver is not against the public interest. NPDES requirements may not be waived.

The RWQCB has initiated a program that regulates certain storm water discharges through NPDES permits. The federal Clean Water Act requires that NPDES permits include technology-based and, where appropriate, water-quality-based effluent limitations. Issued for a 5-year term, an NPDES permit generally contains components such as discharge prohibitions, effluent limitations, and necessary specifications and provisions to ensure proper treatment, storage, and disposal of waste.

Since sources of pollutants in storm water discharge and points of discharge are diffuse, and the methods of reducing the pollutants in storm water discharge are in the developmental stage, water-quality-based numerical effluent limitations are not feasible at this time. Instead, storm water permits will include requirements to prevent or reduce discharges of pollutants that cause or contribute to violations of the water quality objectives. Discharges to inland surface waters are regulated under effluent limitations for conventional pollutants,[12] and selected toxic pollutants discharged to surface waters.[13]

Initial Consideration of RWQCB Issues for Planning Purposes

Further discussion with RWQCB staff is necessary to determine permitting requirements and sampling parameters and limitations for the discharge of Vista Grande storm water to Lake Merced.[14] NPDES permits relate directly to the federal Clean Water Act and apply to discharges to the waters of the United States. WDR permits were established under the State Porter Cologne Act and relate to discharges to waters of the State, including groundwater.

Due to the potential use of lake water as a municipal or domestic water supply, the RWQCB is concerned with the quality of the influent, as it may ultimately affect the quality of water used for domestic water use. Staff at the RWQCB cannot at this time commit to the type of permit the project would require and have requested a meeting with groundwater and storm water staff to determine the appropriate course of regulatory action.

[11] A point source refers to waste emanating from a single, identifiable location.

[12] Conventional pollutants include: Biochemical oxygen demand, suspended solids, 85% removal of biochemical oxygen demand and suspended solids, total coliform organisms, pH, residual chlorine, settleable matter, and oil and grease.

[13] Selected toxic pollutants include: arsenic, cadmium, chromium VI, copper, cyanide, lead, mercury, nickel, silver, zinc, phenols, and polynuclear aromatic hydrocarbon (PAH).

[14] Telephone conversation with Susan Gladstone, Regional Water Quality Control Board, August 28 and September 11, 2000.

Hydraulic Assessment

Kennedy/Jenks (1983) analyzed the response of Daly City's Vista Grande storm water system for 5-, 10-, and 25-year storm events. A 4-hour storm duration was used for these return periods, and an additional 6-hour storm duration was analyzed for a 10-year return period. Predicted peak flow rates in Vista Grande and required storage volumes (surcharge volumes) to handle storm flows in excess of Vista Grande's capacity are summarized in Table 1. No treatment was proposed for water diverted to Lake Merced.

Treatment of storm water before diversion to the lake is assumed to be necessary based on available Lake Merced and storm water quality data and the SFPUC's long-term position on the issue. Because the Kennedy/Jenks assessment of the peak storm flow rates are high and their potential impact to the lake was uncertain, Kennedy/Jenks conducted an evaluation of possible storm water detention alternatives. The storage volumes presented in Table 1 do not include the effect of treatment flow rates on the storage volume required.

In this study, historic storm events were evaluated to look at potential treatment flow rates and possible storage volume requirements. Historic flow rates in Vista Grande were evaluated for the following time periods:

- July 1972 to April 1986, based on an SFPUC model using historic rain gauge data[15]
- December 1998 and March to April 1999, based on measured Vista Grande flows (TRS Consultants, 1999).

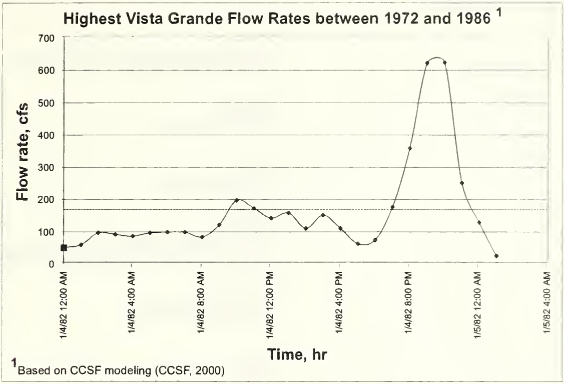
Figure 8 shows the storm hydrograph from the highest flow rates for each of these periods. Figure 9 presents the number of storm events and the period of time per storm event when the 170 cfs capacity was exceeded in the Vista Grande tunnel for the modeled 1972 to 1986 rainfall data. During this time, 21 major storms caused canal flow rates to exceed 300 cfs. Figure 10 depicts the flow through the Vista Grande Canal in response to a longer duration storm with a peak flow of 300 cfs.

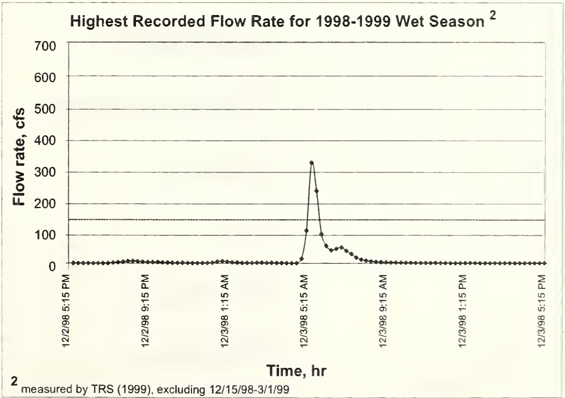
Depending on the treatment option selected, a storm water detention basin may be necessary. An assessment was made to evaluate the size of any detention facility based on treatment facility rates. The volume calculations in this study were based on the following criteria developed for flow diversions:

- If storm water flow exceeds Vista Grande's current capacity (170 cfs), flows higher than 170 cfs will be diverted to the treatment/storage facilities to prevent flooding.
- If the storm water flow is between 75 and 170 cfs, flows higher than 75 cfs will be diverted to treatment/storage facilities to add storm water to the lake at a constant flow rate whenever possible[16].

[15] SFPUC (2000), based on an internal storm water model developed by Leah Orloff of the SFPUC.

[16] The 75 cfs minimum Vista Grande rate is a preliminary number. It is set high enough so that the first-flush – the initial runoff water during a storm event – will not be diverted to the lake but that a more sustained, or routine, flow of water into Lake Merced is considered in addition to the peak storm flows that occur sporadically.

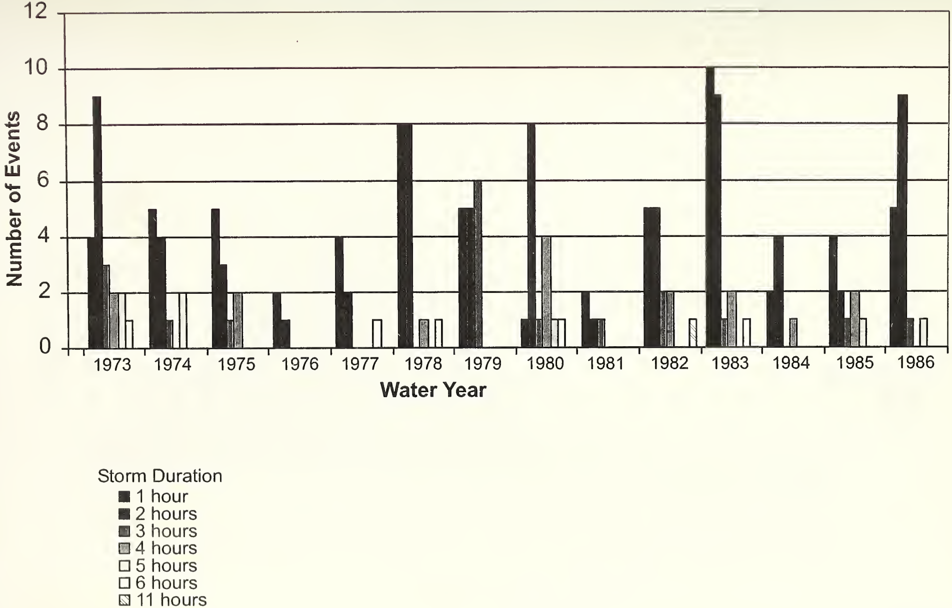




LEGEND

Vista Grande Tunnel Capacity 170 cfs

Figure 8
Hydrographs for
Historic Vista Grande Flows



based on modeled flow data
provided by CCSF

Figure 9
Rainfall Events with Vista Grande Tunnel
Flows Greater than 170 cfs
(Water Years 1973 to 1986)

W082001007SAC exhibit007-Fig9.fh9

From TRS, 1999

Vista Grande Flow Response

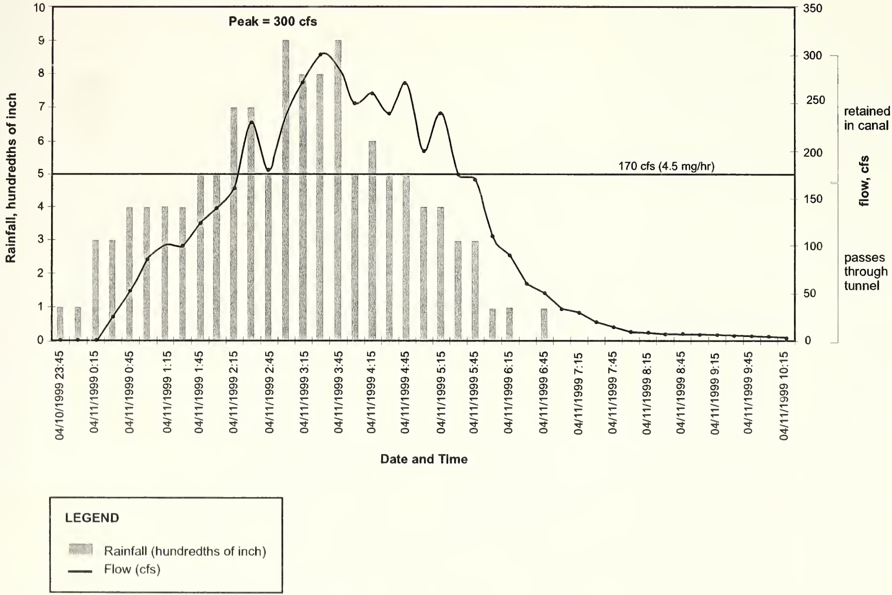


Figure 10
Rainfall Hydrograph Showing
Vista Grande Flow Response

From TRS, 1999

W082001007SAC exhibit016 fig10 fh9

This assessment (Figure 11) indicates that the potential storage requirements decrease as the treatment flow rate increases. For the highest storm event between 1972 and 1986 storage volumes of 31.3 and 24.4 million gallons (mg) are estimated for treatment flow rates of 5 and 40 million gallons per day (mgd), respectively. An additional storage volume of 1.7 mg is required without any treatment capacity for the highest observed flow rates in December 1998.

When the Vista Grande flows were measured during the 1998-99 winter[17], Daly City did not have any reported flow problems in Vista Grande, although several storms had peak flows in excess of 300 cfs. Local flooding in Daly City and San Mateo County did occur, however, as a result of system constrictions. Flooding problems in Vista Grande did not occur because the canal itself has storage capacity of approximately 2 mg[18]. The 1.7 mg of storage needed for the December 1998 storm (Figure 8) was probably provided by the canal.

Figure 11 shows the period of occurrence of particular peak flow rates for the evaluated time period of 1972 to 1986.

[17] A flooding incident occurred on January 18, 1998, but the flow meter was not operational at the time.

[18] This additional storage capacity was not included in the evaluation of potential volumes shown in Figure 8.

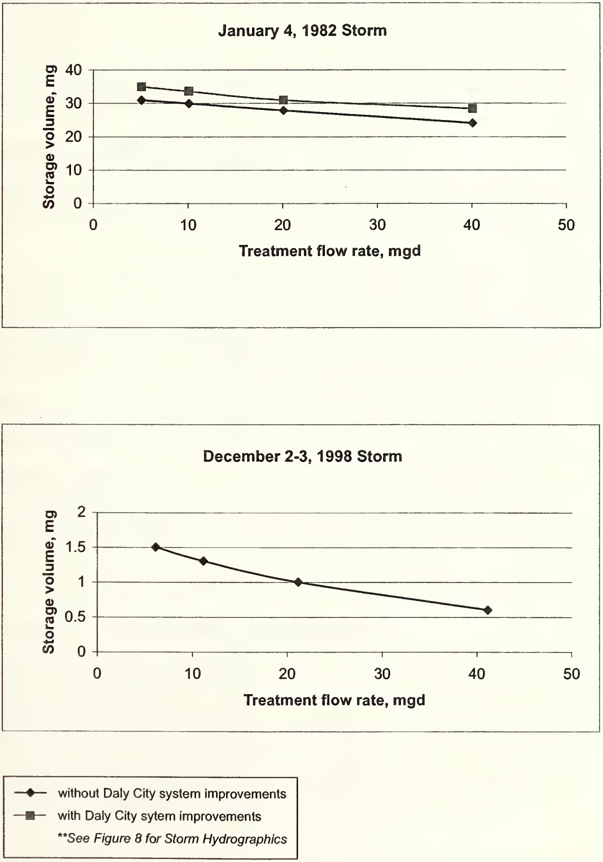


Figure 11
Comparison of Maximum Flow Rates to Storage Volume Requirements

Discussion of Alternatives

Seven alternatives were considered during this phase of the Feasibility Evaluation. Table 2 summarizes the seven alternatives, and Table 7 summarizes the key issues for each. The alternatives are discussed in detail below.

Alternative 1: Direct Discharge

Description: Excess storm water from Vista Grande would be introduced to Lake Merced using the approach initially described by Kennedy-Jenks (1983). In this alternative, a series of overflow structures and trash gates would introduce water to South Lake and Impound Lake.

The Lake Merced overflow structure is also considered as a mechanism by which water can be conveyed to the lake. The Lake Merced overflow structure is located just west of the point at which Daly City treated wastewater effluent is discharged back into the Vista Grande Canal. The overflow channel was built to allow excess water from Lake Merced to overflow into the canal. It may be possible to utilize this existing channel to direct excess storm water flows from the Vista Grande Canal to Lake Merced in the reverse direction.

Advantages: This alternative would be easiest to construct and was determined by Kennedy/Jenks to be the least-cost alternative for its evaluation. Using the Lake Merced overflow structure would require minimal construction.

Disadvantages: All storm water introduced to the lake would be untreated and could negatively impact water quality and habitat at Lake Merced. There would be minimal control of the rate and volume of the discharged water, which could negatively impact shoreline conditions and habitat at the lake by raising the lake level too quickly for local plants and animals to adapt.

This alternative is not being pursued at this time based on the disadvantages cited above.

Alternative 2: Structural Control Measures

Description: Installation of overflow structures, treatment facilities, and trash racks would be designed, constructed, and operated to enable storm water from Daly City and unincorporated areas of San Mateo County to enter the Lake. The City-owned property west of the intersection of Lake Merced Boulevard and John Muir Drive would be the most-likely location for the treatment facilities. It is assumed that some portion of the 'first-flush'[19] would continue to be routed through Vista Grande to the ocean outfall and would not be diverted to the lake. This would reduce the size of the treatment facilities, because the higher-level of treatment for the "first-flush" water would not be required.

[19] The "first-flush" water quality is generally poor because of the oils and other materials washed off of impervious surfaces that are suspended within the initial runoff water.

TABLE 7
Summary of Evaluated Criteria for Each Alternative
Vista Grande Diversion Feasibility Study

		ALTERNATIVES				
CRITERION	**DESCRIPTION**	**Direct Discharge**	**Structural Control Measures**	**Constructed Wetlands**	**Detention Basin**	**Depth Filters**
Performance	Pollutant removal efficiency	None	High removal of oil and grease Moderate removal of TSS Low nutrient and coliform removal	Good for BOD, TSS, nitrogen and phosphorus. Moderate for coliform removal. May not control detection limit discharge concentration	None without supplemental treatment	High TSS (and hence Turbidity) removal
Siting	Areal requirements, inflow and outflow structures, O&M access, and public recreation facilities	One or more overflow structures from Canal to Lake	Would depend on upstream storage potential and specific technology used	Land area requirements may surpass land available.	A -Depends on size of basin, could be relatively small, land may not be available B - Already exists	Requires 70 to 140 ft^2 of filtration area for one MGD treated
Environmental Compliance and Impacts	Permitting and compliance issues, potential project impacts (siting and construction), and public perception.	Stormwater into Lake would be untreated and potentially impact water quality and habitat	Possibly low issues. Would need to blend in with surroundings.	Regulatory requirements can be stringent, significant ecological benefits, enhances educational and public recreational benefits	A -Habitat impacts from construction B-Possible extreme fluctuations in water added to Impound Lake.	Disposal of Backwash water
Beneficial Uses	Positive impacts to lake and stormwater issues.	Provides a reliable supply of water to Lake Merced. Restores a portion of historic drainage basin.	Oil/grease, and TSS levels decrease	No waste residuals, water quality improvement, habitat improvement	A -Flow into lake would be over a longer time period	Would decrease the TSS and associated contaminant levels
Capital Costs	Construction costs.	Relatively low	Moderate capital cost	Potentially high	A -Relatively high B -Moderate	Capital cost varies between $230,000 and $480,000 for one MGD treated
Operation and Maintenance Costs	O&M costs, expected life cycle, maintenance issues.	Continued water quality and habitat impact monitoring for the life of the project. Cleanout of trash gates	Low to moderate operational costs Clamshell clean out of filters	Continued monitoring over time, O&M mainly hydraulic		Low to moderate operational costs
Capacity	Potential impacts on Lake Merced levels and stormwater discharge constrictions	Will increase Lake Merced water levels	Discharge of treated water will increase Lake Merced water level	Will increase Lake Merced water levels	A -Depends on the size of the constructed facility. B -Impound Lake has capacity. Could compromise integrity of viaduct	Discharge of filtered water will increase Lake Merced water level
Other Issues	What else may be needed to fully evaluate or design the alternatives	This alternative is not being pursued because of source water quality concerns	Would require additional treatment for coliform	Public and regulatory acceptance can be influential		Performance can be increased with addition of chemicals. Pilot plant studies are strongly recommended.

TABLE 7, *continued*
Summary of Evaluated Criteria for Each Alternative
Vista Grande Diversion Feasibility Study

CRITERION	DESCRIPTION	ALTERNATIVES: Grassy Swales	Infiltration Basin	Ultrafiltration	Microfiltration & reverse osmosis	Chemical Precipitation	UV Radiation	Chlorination
Performance	Pollutant removal efficiency	Removal of TSS, BOD and metals, some coliform removal	Removal of TSS, phosphorus, nitrogen, metal, coliform, and soluable pollutants	High TSS removal, partial pathogen removal, low removal of other chemicals of concern	High removal of all constituents of concern	High removal of heavy metals such as copper, zinc, lead, moderate to high removal of TSS	High destruction of pathogens	High destruction of pathogens
Siting	Areal requirements, inflow and outflow structures, O&M access, and public recreation facilities	Depending upon size of basin and fraction to be treated	Would be most effective at upstream locations away from Lake Merced and Vista Grande	Modular, relatively small footprint	Modular, relatively small footprint	Requires more space compared to R/O system	relatively small footprint	Requires 1-2 hours of detention time basin
Environmental Compliance and Impacts	Permitting and compliance issues, potential project impacts (siting and construction), and public perception.	Minimal, may have higher land demands than available in the area	Minimal	Disposal of backwash water	Disposal of brine	Disposal of sludge containing chemicals		Undesired chlorination byproducts. Dechlorination would probably be required.
Beneficial Uses	Positive impacts to lake and stormwater issues.	Natural treatment	Would increase groundwater recharge to the Westside Basin	Lake water quality in terms of TSS concentration increases	Overall lake water quality increases	Lake water quality in terms of TSS concentration would increase, stormwater qulity would increase in terms of heavy metals	Pathogen concentration decreases in storm and lake water	Pathogen concentration decreases in storm and lake water
Capital Costs	Construction costs.	Relatively high	Would depend on size, location and construction. Assumed to be realtively low.	Significantly high capital cost compared to depth filters	Most expensive treatment alternative evaluated	Moderate capital cost	Higher capital cost compared to chlorination	One of the least expensive disinfection method
Operation and Maintenance Costs	O&M costs, expected life cycle, maintenance issues.	Moderate	Lower. Cleanout, inspection.	Higher operational costs compared to depth filters	Very high operational costs	Operational costs can be high associated with the chemical requirements	Higher operational cost compared to chlorination	Operational costs are dependent on the amount of chlorine required
Capacity	Potential impacts on Lake Merced levels and stormwater discharge constrictions	Would depend on area to be constructed	Low	Depends on capacity of treatment facility	Depends on capacity of treatment facility	Depends on capacity of treatment facility	Depends on capacity of treatment facility	Depends on capacity of treatment facility
Other Issues	What else may be needed to fully evaluate or design the alternatives	May not be compatible with high flow rates. Most appropriate with steady, sustained flow rates.	Would reduce flows to Vista Grande but would not directly benefit Lake Merced.	Pilot plant studies are recommended.	Pilot plant studies are recommended.	Pilot plant studies are strongly recommended	Pilot plant studies are recommended before implementation	Pilot plant studies are recommended before implementation

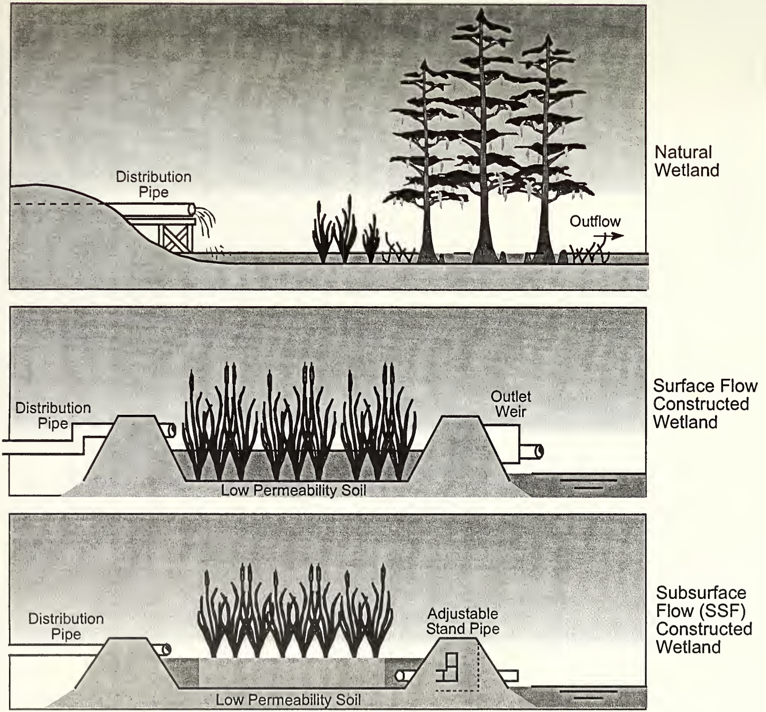


Figure 12
Major Categories of
Treatment Wetland Systems

from Kadlec and Knight, 1996

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BOD) and biological assimilation, such as phosphorus and nitrogen, both essential plant nutrients, and important inorganic micronutrients, such as iron, calcium, silica, carbonates, and sulfates. For some cations and anions, such as sodium or chloride, or aggregated inorganic parameters, such as hardness or TDS, treatment is usually little more than

dilution caused by incident precipitation. Organic compounds, lumped as BOD, and suspended particulates, lumped as TSS, are readily removed by wetlands. As shown in Table 8, various wetland internal recycling processes impose lower limits on performance, making it infeasible to attain detection limit concentrations for most conventional parameters.

TABLE 8
Generalized Treatment Wetland Performance Characteristics
Vista Grande Diversion Feasibility Study

Parameter	Efficiency	Removal Limit
BOD	50-90%	2-10 mg/L
TSS	50-90%	2-10 mg/L
Total Nitrogen	40-90%	1-3 mg/L
Total Phosphorous	10-90%	<1 mg/L
Fecal Coliform	80-90%	<100-1,000 col/100 mL
Metals	50-90%	Below detection

Compiled from Kadlec and Knight (1996) and various sources.

The constituents of interest for the Vista Grande flows include conventional pollutants, such as TSS (50 mg/L), BOD/COD (25 to 60 mg/L), total recoverable oil and grease (20 mg/L), metals (correlated with TSS), TKN (6.5 – 7.8 mg/L) and coliform (levels greater than 200,000 mpn/100ml, prior to Daly City identifying the source of the coliform within its stormwater system). Other parameters, such as EPA 608 contaminants, occurred at or below detection levels. In total, these loading concentrations fell well within the range of concentrations that wetlands can remove.

Surface flow wetlands offer significant potential for reduction of pollutants through combined physical, chemical, and biological activity in the wetland sediments, and they offer the most potential for creating the ancillary benefits of wildlife habitat, public recreational uses such as birdwatching and nature study, and surface runoff flow retention. Alternating zones of deep water and shallow emergent marsh offer a wide range of environments for aerobic and anaerobic processes that are suitable for reducing nitrate and sulfate. Interspersed with habitat islands, these wetland features can create optimal habitat for waterfowl, wading birds, and other species valued for ecology and recreation.

Most surface flow treatment wetlands receiving pretreated municipal wastewater attract significant wildlife populations (Kadlec and Knight 1996). As a consequence of the diversity of wildlife attracted to treatment wetlands and their more general aesthetic qualities, many treatment wetlands provide public use functions. The use of treatment wetlands by wetland dependent wildlife and by humans is incidental to their water quality functions, but

considerable design guidance is available to provide these ancillary benefits through careful project planning (Knight 1997; Knight 1992).

Additional benefits of treatment wetland technology include:

- Treatment wetlands may be relatively inexpensive to construct and operate. The primary costs consist of the land, grading, diking and planting. Properly designed and constructed treatment wetlands are essentially self-maintaining systems.
- Treatment wetlands can be located at points within the landscape (remote and/or wet areas) that might otherwise present construction and management difficulties.

Advantages: Treatment wetlands offer distinct advantages for water quality improvement. Because treatment wetlands are primarily passive and driven by natural energies, such as gravity, sunlight driven photosynthesis, solar insulation, wind, and water movement, operational maintenance requirement costs are minimal and center on hydraulic maintenance. Few waste residuals are created, and those that are become part of the wetland substrate over time. Significant ecological benefits can be realized by including wildlife habitat features in wetland planning, where the quality of the water to be treated is appropriate. Public benefits can be substantial through the inclusion of recreational and educational amenities such as boardwalks, access trails, and overlooks.

Disadvantages: Treatment wetlands are not universally applicable to all water quality improvement needs. Limitations that need to be weighed in any wetland application include the land area available, potential monitoring requirements, public and regulatory acceptance, limitations on performance, and, in some cases, concerns over ecological risk to wildlife.

Because they are shallow (1 to 2 feet), and because the water to be treated usually resides in the wetland for several days before discharge, land area requirements may surpass the area of land available. Areas of steep terrain may require extensive earthwork to create a suitable level grade, potentially at great expense. Additionally, a constant stream of water to the system may be required to provide continued support to plant life.

Because they are viewed as an innovative technology in some regions, wetlands may require monitoring to evaluate performance. While some monitoring is always advisable, this can pose unique and sometimes extensive operational costs and requirements, depending upon the project issues. For large wetlands, the project can become a land management issue as much as a water quality management issue.

Public and regulatory acceptance of the wetlands can be an influential determining factor in treatment wetland implementation. Public concerns over site aesthetics, vector management, and proximity to neighborhoods need to be addressed. Federal, state, and local regulatory agencies may or may not have significant experience with treatment wetlands and may need to be informed of the principles of wetland design and performance before the project can be accepted.

There are natural limitations to wetland performance. While pollutants such as BOD, TSS, nitrogen, and phosphorus are readily assimilated in treatment wetlands, they are also extensively recycled between the wetland sediments and overlying water. A background or detection limit discharge concentration is not always achievable, depending upon the

constituent, loading rate, and target treatment concentrations. Discharge goals and treatment wetland performance require careful assessment before recommendations can be made.

Alternative 4: Detention Basin

Two options have been considered for a storm water detention basin – a modified version of the alternative initially discussed in the Kennedy/Jenks report and Impound Lake. Because of the extremely diverse issues associated with these two alternatives, they are considered as Alternatives 4A and 4B.

Alternative 4A: Vista Grande Detention Basin

Description: Kennedy/Jenks (1983) initially suggested expanding Vista Grande between Lake Merced Boulevard and the tunnel entrance. The width of the basin would be wider (140 to 230 feet) nearer to Lake Merced Boulevard and would narrow to approximately 30 feet north of the viaduct because of the CCSF's infrastructure. The storage capacity of the detention basin would be between 24 and 38 MG. Water could be diverted to Lake Merced at whatever treatment capacity is considered feasible. A 38-MG detention basin with an average depth and width of 10 and 25 feet, respectively, which starts near Lake Merced Boulevard and end at the tunnel opening, would be approximately 3,800 feet long.

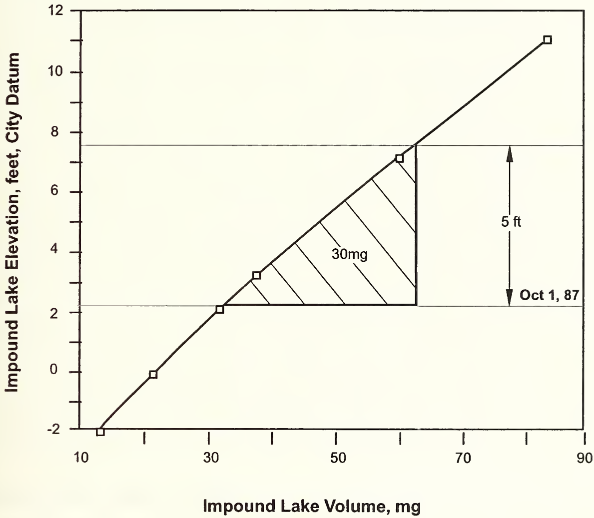
Advantages: Retaining the storm flows would allow some measure of flow equalization and provide water to the lake at a more constant rate, thereby reducing the size of the treatment facilities needed. Additional benefit would be provided by physical settling and biological and chemical assimilation processes. Because of its location between John Muir Boulevard and Vista Grande, use of this land is assumed to have minimal impact to local habitat.

Disadvantages: This alternative was initially ruled out by Kennedy/Jenks because of the cost and because the land upon which the basin would be constructed is owned by CCSF. The 1983 cost estimate for the storage basin ranged from \$5.6 to \$9.1 million. This would be approximately \$7 to \$11.4 million in 2000 dollars. The area that would be used for the detention basin is currently unused and is covered with ice plant and trees.

Alternative 4B: Impound Lake Detention Basin

Description: Impound Lake is the southernmost part of Lake Merced. It is hydraulically separated from the rest of Lake Merced by a sandy berm located beneath the viaduct carrying CCSF wastewater lines. Excess storm water from Vista Grande would be diverted directly to Impound Lake and then routed to South Lake.

A bathymetric survey of Lake Merced conducted in 1988 (Entrix) shows the bed elevations of Impound Lake and South Lake. The bottom of Impound Lake was estimated to be –7.5 feet (1.3 msl) and –18.3 feet (-9.7 msl) for South Lake. This information, if still correct, can be used to determine the approximate volume that could be stored in Impound Lake before water would spill to South Lake, without accounting for leakage out of the lake. The 1988 survey was conducted at the beginning of the drought, when water levels were beginning the significant drop from sustained recorded levels. It is not clear from the Entrix report if Impound and South Lakes were physically connected during the survey, although the



Notes:
After Entrix (1988)
Current elevation of Impound Lake is not known
City Datum is 8.616 feet higher than mean sea level (MSL)

Figure 13
Estimated Storage Volume
of Impound Lake

elevation difference between the surface of the two lakes was approximately 1 foot (3.1 and 2.1, respectively, city datum). Figure 13 shows the estimated volume of Impound Lake, as estimated from the bathymetric survey data.

There are two key issues to be addressed in evaluating if Impound Lake can be used to receive water from Vista Grande. First, the structural integrity of the viaduct is uncertain. If water were to be impounded behind the viaduct, it could effectively act as a dam because there are concrete walls between the viaduct pilings. The function of these walls is uncertain. Scour could also occur at the base of the walls as water flows from Impound Lake to South Lake, further compromising the structural integrity of the viaduct. Second, if water is added to Impound Lake and it does not reach the top of the sandy berm, getting water from Impound Lake into South Lake would require pumping or modification of the berm. This would require a US Army Corp of Engineers Section 404 water quality permit.

Advantages: Excess storm water from Vista Grande would be diverted directly to Impound Lake and then treated prior to discharge to South Lake. Impound Lake is the shallowest portion of Lake Merced. It is also considered to be hydraulically separated from the underlying aquifer (that is, the water table in the underlying aquifer is below the bottom of Impound Lake). As a result, the amount of water in Impound Lake fluctuates and is extremely sensitive to variable recharge conditions. Impound Lake has a similar capacity to that of Alternative 4A but would have a lower construction cost. Physical settling and biological and chemical assimilation processes would provide additional treatment.

Disadvantages: This alternative would introduce untreated storm water directly to part of Lake Merced. Because Impound Lake is separated from the underlying aquifer, it leaks at a constant rate, as long as the "decoupling"[20] is maintained. Therefore, untreated storm water would also be introduced to the shallow aquifer immediately below the lake. Periodic inundation of Impound Lake could adversely impact the existing plant and animal habitat within the Impound Lake basin. Finally, the integrity of the viaduct, if Impound Lake were inundated and South Lake were not at a similar elevation, would have to be assessed.

Alternative 5: Depth Filters

Description: Depth filters involve the use of a porous medium (such as sand, anthracite, garnet, or synthetic fibers) to remove suspended particles from water. Several variations on this type of storm water filtration system are in use. Relative removal efficiencies of depth filters compared to other treatment technologies for various contaminants are shown in Table 9.

Each of the depth filter approaches would include a storage basin for sedimentation, oil and grease removal and floatable trapping. Water flows from the first chamber to the second chamber through a submerged opening and either onto the filter bed, which removes silt and clay-size particles and other potential contaminants, depending on the media, or vertically through an upflow bed for additional denitrification, metal removal or TSS reduction. Filtered water is collected by a gravel and perforated pipe under-drain system and flows into a third chamber, which contains a clearwell and a connection to the storm

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[20] Decoupling occurs when a surface water body is physically separate from the underlying aquifer – there is no direct hydraulic connection.

drain system. Overflow protection can be provided by placing the filter off-line or by providing a weir at the top of the wall connecting the filter chamber with the clearwell chamber to serve as an overflow.

Because it is not practical for space reasons to build a filter capable of treating runoff at the peak flow rate, filter designs typically include a sedimentation or holding tank designed to collect peak flows. Typically, the sedimentation/filter basin is sized to hold the volume of runoff for one storm event and the water is treated within 40 hours.

Advantages: Depth filters remove the suspended particles (that is, turbidity) from the storm water, including particulate nutrients as well as floatables, such as oil and grease. Other constituents of concern (e.g., total coliform and metals) that are attached to the particulate matter in the storm water will also be removed to a varying degree, depending on the influent concentration. Their compact size and potentially underground construction make them a preferable treatment system for highly urbanized areas, and they can be readily designed as an off-line system. Choice of filtration media can optimize the targeted constituents for removal. Depth filters are expected to be less expensive to construct and operate as compared to intensively engineered treatment systems such as membrane filters.

Disadvantages: Periodic inspection and maintenance is essential to ensure continued reliable operation. It may be necessary to dispose of backwash water and/or replaced media. Without consistent and proper backwash, the potential for clogging is high; this could have an adverse effect on water movement through the treatment system. The use of depth filters becomes limited when the size of the suspended particles to be removed is smaller than 2 to 5 microns. Similarly, storm water flows with high dissolved nutrient and metals concentrations may not be effectively treated.

Alternative 6: Grassy Swales

Description: Vegetated systems such as grass filter strips and vegetated swales are used for conveying and treating storm water flows. Open channel vegetated systems are alternatives to traditional curb-and-gutter and storm sewer conveyance systems. By conveying storm water runoff in vegetated systems, some degree of treatment, storage and infiltration can be provided prior to discharge to the storm sewer system. This can help reduce the overall volume of storm water runoff that is generated from a particular drainage area (EPA, 2000).

Grass filter strips are densely vegetated, uniformly graded areas that intercept sheet runoff from impervious surfaces such as parking lots, highways and rooftops. Turf grasses and grasses tolerant of some inundation are frequently used, but alternatives such as forest and shrub systems have been used. Vegetated swales are broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. Vegetated swales are designed to slowly convey storm water runoff and in the process trap pollutants, promote infiltration, and reduce flow velocities. Vegetated swales may be either dry or wet depending upon topographic position, hydraulic loading, and soil infiltration rates.

Advantages: Grassy swales can either accept sheet flow directly from impervious surfaces, or concentrated flow can be distributed along the width of the strip using a gravel spreader. Low maintenance and inexpensive operations make this a widely used technology.

Disadvantages: Land area requirements may exceed the available area, depending upon the flow volume to treat. Some irrigation may be required to maintain the system once constructed. Limited treatment is expected, given the high hydraulic loading rates applied.

Alternative 7: Infiltration Basin

Description: An infiltration basin is an area of land surrounded by a bank or berm that retains the storm water until it has infiltrated through the base of the basin. Infiltration practices reduce storm water runoff by increasing groundwater recharge. An infiltration basin should drain within 72 hours of a storm event and should be dry at all other times. The contributing drainage area for an infiltration basin is usually between 2 and 15 acres. The basin is frequently excavated into the ground, but berms are sometimes used to enclose an area on the ground surface or on one side if the basin is constructed on sloping ground. Although infiltration is a simple concept, infiltration devices must be designed carefully and maintained if they are to work properly. Poorly installed or improperly located devices fail easily and do not achieve the desired pollutant removal efficiency. Furthermore, and depending on the quality of the runoff, pretreatment will generally be necessary to lower the failure rate of the trench.

Advantages: Infiltration basins can improve the quality of storm water runoff. A properly maintained trench can remove particulate and soluble pollutants. Effective removal of suspended particles, phosphorus, nitrogen, heavy metals, coliform, and organic matter is accomplished through adsorption by soil particles and biological and chemical conversion in the soil. Rates of pollutant removal are contingent on the type of soil (sandy soils are less effective at removing nitrates and heavy metals than less porous soils).

Disadvantages: Siting considerations are extremely important in the construction of an infiltration trench. The use of trenches is restricted by soil type, depth of water table, slope, and contributing area conditions; these issues require professional assessment. Maintenance requirements include regular inspection, cleaning of inlets to prevent clogging, mowing and inspection of observation wells to maintain proper operation. Insects, odors, and soggy ground can be nuisances.

Alternative 8: Other Technologies

Description: The three other types of technologies considered during the evaluation process were membrane filtration (ultrafiltration, microfiltration, and reverse osmosis), chemical precipitation , and disinfection (chlorination and ultraviolet). Table 9 compares these types of treatment options to depth filter and structural control measures.

Membrane Filtration: Ultrafiltration separates suspended and colloidal particles when water flows through the semipermeable membrane by applied pressure. Microfiltration is typically used for clarification, disinfection, and pretreatment for reverse osmosis. Suspended particles are removed by the microfiltration unit, and dissolved solids are removed by the reverse osmosis unit.

Disinfection: Disinfection destroys pathogens and biologic contaminants through chlorination or ultraviolet radiation.

Chemical Treatment: Chemicals, such as alum or iron salts, can be added to cause flocculation and precipitation. The process removes TSS and heavy metals. It usually requires a settling basin.

TABLE 9
Treatment Efficiency Comparison
Vista Grande Diversion Feasibility Study

	TREATMENT EFFICIENCY					
CONSTITUENT OF CONCERN	**Depth Filters or Cloth Type Filters**	**Ultrafiltration**	**Microfiltration or Reverse Osmosis**	**Chemical Precipitation**	**Chlorination or UV Disinfection**	**Oil/Sediment Interceptor**
TSS/Turbidity	High	High	High	Moderate to high	No significant	Low to moderate
Total Coliform	Low to moderate – coliform attached to suspended particles	Low to moderate – coliform attached to colloidal and suspended particles	High	Low to moderate – microorganisms attached to suspended particles	High removal	Minimal
Copper	Low to moderate – adsorbed in particulate matter	Low to moderate - adsorbed in particulate matter	High	High	Minimal	Minimal
Lead	Low to moderate - adsorbed in particulate matter	Low to moderate - adsorbed in particulate matter	High	High	Minimal	Minimal
Zinc	Low to moderate - adsorbed in particulate matter	Low to moderate – adsorbed in particulate matter	High	High	Minimal	Minimal
Oil and grease	Low	Low to moderate	High	Low	Minimal	High removal

Advantages

Membrane Filtration: Ultrafiltration would remove the suspended and colloidal particles (and hence the turbidity) from the storm water. Higher TSS removal efficiency would be obtained compared to depth filters. As with depth filters, other constituents of concern would be partially removed. This alternative requires a relatively small foot print. Microfiltration/reverse osmosis would remove all of the chemicals of concern.

Disinfection: Disinfection would destroy disease-bearing pathogens. Chlorination is relatively inexpensive.

Chemical Treatment: The storm water has a pH value of 7, which is considerably lower than the pH of Lake Merced (which ranges between 8.2 and 9.1). Therefore, the addition of caustic soda to increase precipitation efficiency would result in an effluent with pH values similar to those in Lake Merced. Chemical precipitation is less expensive compared to reverse osmosis, which is the other treatment option for heavy metals.

Disadvantages

Membrane Filtration: Because the average membrane pore is small, operating costs to supply the required amount of pressure are high. Capital costs are significantly higher than the costs for depth filters. Disposal of brine or backwash water must be addressed.

Disinfection: Chlorination requires contact time and dechlorination of the water prior to discharge to Lake Merced. Undesired chlorination byproducts, such as trihalomethanes (THMs), are generated when chlorine reacts with the organic matter in the storm water. Ultraviolet (UV) systems are more expensive to construct and operate than chlorination systems, and there is less operational experience with UV than with chlorination.

Chemical Treatment: Sludge that consists of treatment chemicals is generated. Operating costs can be high because of chemical costs.

Ranking of Alternatives

The various alternatives were evaluated by assessing potential issues such as construction and operation and maintenance costs, environmental constraints or impacts, and siting. This evaluation is summarized in Table 8. Numeric values were then assigned to the evaluation results to rank the alternatives. These numeric assignments were general evaluation made using existing information. The numbers provide general assessment of the criteria relative to the other alternatives and the overall impacts. The numbers were not intended to be absolute values, but were developed to facilitate evaluation of the alternatives. Table 10 summarizes how the values were assigned and provide an example of the assignment, as they pertain to evaluating the Siting issues evaluation criterion. Table 11 shows the result of the alternative ranking.

TABLE 10
Key to Numeric Assessment Using the Siting Issues Evaluation Criterion as an Example
Vista Grande Diversion Feasibility Study

Value	Approach	Application
-1	The issues associated with implementing the alternative adversely impacts the evaluation criterion	Other Technologies: Implementation of most of these options would require construction of an above-grade facility. Because the area is relatively open and the local sentiment is to preserve the area to the extent possible, it is likely that this would be difficult to implement.
0	The issues associated with implementing the alternative have either no impact or minimal impacts to the evaluation criterion	Detention Basins: Either A or B could be implemented without major impacts. Expansion of the existing Vista Grande canal would involve an area that is currently neglected and covered with ice plant. Implementation of B would be done with minimal modification to the existing area.
+1	The issues associated with implementing the alternative benefit the evaluation criterion	Constructed Wetlands: this alternative would be used to enhance the existing area using native species and would involve removing the extensive existing ice plant. This approach would be used to improve the ecosystem within Impound Lake.

Each of the alternatives assumes that a conveyance facility will need to be constructed under John Muir Drive. The existing overflow line that enters the canal downstream of the Daly City secondary effluent line, is probably not a viable alternative. Because the assumption is considered to be applicable to each alternative, it is not considered further in the alternative assessment.

The initial consideration of where to divert the water from Vista Grande is assumed to be as close to Lake Merced Boulevard as possible. This would reduce the flow in Vista Grande and reduce the stress on the system where the canal narrows upstream of the tunnel.

TABLE 11
Numeric Assessment of Alternatives
Vista Grande Diversion Feasibility Study

EVALUATION CRITERIA	Direct Discharge	Structural Control Measures	Constructed Wetlands	Detention Basin	Depth Filters	Grassy Swales	Infiltration Basin	Other Technologies
Performance	-1	+1	+1	A -1 B +1	+1	0	+1	+1
Siting	+1	+1	+1	A 0 B 0	-1	-1	0	-1
Environmental Compliance and Impacts	-1	0	0	A 0 B -1	-1	0	0	0
Beneficial Uses	-1	+1	+1	A +1 B +1	+1	+1	+1	+1
Capital Costs	+1	0	-1	A -1 B 0	-1	0	0	-1
Operation and Maintenance Costs	0	-1	0	A 0 B 0	-1	0	-1	-1
Capacity	+1	+1	+1	A +1 B -1	+1	-1	-1	0
Other Issues	-1	0	0	A -1 B 0	0	0	0	-1
TOTAL	-1	+3	+3	A -1 B 0	-1	-1	0	-2

The results of the numerical analysis indicate that the structural control measures and the treatment wetlands have the highest individual ranking. Both of these treatment alternatives are effective at removing TSS, which was shown earlier to be highly linked to metals concentrations. Structural control measures are more effective at oil and grease

removal, whereas treatment wetlands are more effective at nutrient removal[21] and coliform removal (Table 12).

Because neither treatment method offers high-level treatment of the suite of water quality parameters of potential concern, subsequent assessment should be considered for the following approaches to diverting storm water from Vista Grande to Lake Merced:

1. Structural Control Measures (450 cfs) with discharge to South Lake
2. Structural Control Measures (450 cfs) with discharge to treatment wetlands in Impound Lake
3. Structural Control Measures (300 cfs) with discharge to treatment wetlands in Impound Lake. Higher flow rates during peak storm events would be discharged directly to the treatment wetlands in Impound Lake with the assumption that exceedingly high flows would be relatively free of direct contaminants.
4. Structural Control Measures (300 cfs) with discharge to Impound Lake. Widening of Vista Grande canal to act as a short-term detention basin. Assessment of construction of treatment wetlands.

TABLE 12
Comparison of Water Quality Parameter of Concern and Highest Ranked Alternatives Effectiveness
Vista Grande Diversion Feasibility Study

Water Quality Parameter	Structural Control Measures Effectiveness	Treatment Wetlands Effectiveness
TSS	Moderate	Very Good
Oil and Grease	Good	Good
Total Coliform	Moderate	Moderate
Copper	Moderate	Good
Lead	Moderate	Good
Nickel	Moderate	Good
Silver	Moderate	Moderate
Zinc	Moderate	Good

Because preliminary evaluation indicates that most of the metals identified in the storm water may be associated with the suspended portion of the samples, both methods are equally effective.

[21] Nutrients have not been adequately analyzed in past storm water sampling events to determine whether they are an issue. Because of the lawns and golf courses in the Daly City drainage area, it is assumed that nutrients may be a potential water quality issue. Additional sampling is needed to assess nutrient concentrations in Vista Grande storm water.

Conceptual Design of Preferred Alternative

General Discussion of Preferred Alternative

The proposed approach will implement the two highest ranked alternatives to provide maximum benefit to both Lake Merced and the stormwater system. The uncertainty regarding the water quality of the water in the Vista Grande canal prevents a development of a definitive implementation plan at this point. However, this section presents how the project can be implemented if total coliform levels are lowered in the Vista Grande stormwater.

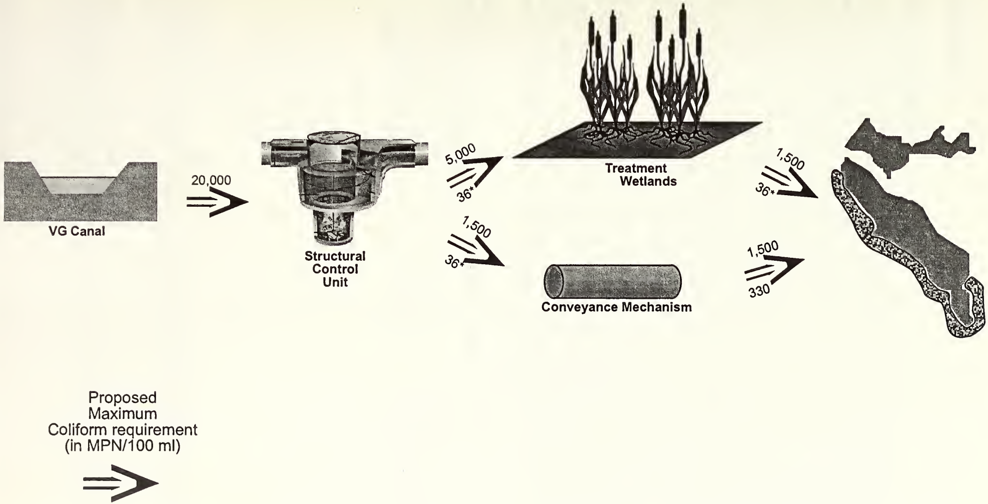
Figure 14 presents the proposed approach to diversion and treatment of water from the Vista Grande to Lake Merced. It entails installation of structural control measures (such as CDS units or equivalent) just west of the Vista Grande canal possibly coupled with development of treatment wetlands along both Impound Lake and the south shore of South Lake. This alternative assumes that Daly City is able to reduce its stormwater coliform levels to approximately 20,000 MPN/100ml or lower. The structural control method would provide an initial treatment and removal of metals, oil and grease, nutrients, and coliform by removing trash and sediment from the stormwater. The outflowing water would then be conveyed under John Muir Drive to both Impound and South Lakes. Depending upon the water quality after treatment by the structural control unit, the outflow would be conveyed through treatment wetlands for additional 'polishing' before entry into the waters of Lake Merced or direct release to the lake.

The two limiting factors in this approach are the treatment wetlands and the ability of the lake to receive water. In this evaluation, the following assumptions have been made:

- Land available for development of treatment wetlands is 23 acres
- Lake Merced can receive up to 330 cfs for a period of up to three hours, based on 300 cfs to South Lake and 30 cfs to Impound Lake, for a rise in each lake of 6 inches per storm event
- Daly City is able to identify and correct the source of coliform in its stormwater system and achieve a level of coliform that is equal to or less than 20,000 MPN/100ml
- The final water quality, whether after flow through the structural control unit or treatment wetlands, prior to discharge to Lake Merced is to be 1,500 MPN/100ml[22]

Further discussion of this alternative and pilot testing are provide below.

[22] The target water quality goals and approach to their application will be identified and negotiated with the RWQCB after completion of pilot testing and additional canal and lake water quality testing.



* based on some infiltration through substrait, 23 acres of wetlands, and a 4-hour storm event

Figure14
Preferred Alternative
Approach

W082001007SAC exhibit013-Preferred_Alternative.fh9

Approach

Water Quality Issues

Uncertain water quality conditions in Vista Grande canal when the project will be implemented has resulted in developing assumptions for preparing the preferred alternative conceptual design. Daly City is currently in the process of attempting to identify the mechanism by which coliform is entering its stormwater system. This investigation involves video logging, smoke testing, and water quality sampling. To date the source has not been determined. However, Daly City has identified several in basin practices where implementation of best management practices and modification of conveyance facilities will improve the overall quality of stormwater conditions within the drainage basin. However, none of these situations appears to be the source of the coliform levels that frequently occur over 200,000 MPN/100ml. Coliform levels in the Vista Grande canal currently (that is, under non-storm conditions) range from less than 100 to approximately 1,000 MPN/100ml (per Patrick Sweetland, Daly City). Therefore, the high levels of coliform found in the canal during the 2000-2001 sampling appears to only occur during storm events.

Coliform levels during the 2000-2001 sampling of stormwater in the Vista Grande Canal were highly variable (Table 13). Four samples collected at VGDN (just upstream of the tunnel) had coliform levels of less than 10,000 MPN/100ml, which indicates that the 'source' of the coliform is intermittent and that 'background' coliform levels appear to be relatively low. Therefore, if Daly City can isolate and correct the source of the coliform, there is reasonable opportunity for successful project development.

TABLE 13
Summary of Total Coliform Ranges in 2000-2001 Vista Grande Samples
Vista Grande Diversion Feasibility Study

Range of Values[a]	VGUP	VGDN
Total Number of Samples[b]	*15*	*15*
<1,000	0	0
1,000 to <10,000	0	4
10,000 to <50,000	2	3
50,000 to <100,000	6	1
100,000 to <240,000	5	2
>240,000	2	5

[a] Units are MPN/100 ml

[b] The duplicate sample collected on January 11, 2001 was considered to be one sample and the higher value was used in this assessment. The samples collected on October 26 and 30, 2000 were not considered because the detection level was too low for comparison with the samples collected during the remainder of the season.

Daly City is confident that it will find the source of the coliform through continued investigation. If, at the start of the wet weather season, the source has not been identified, then an intensive sampling program is planned for the initial storm events. From these

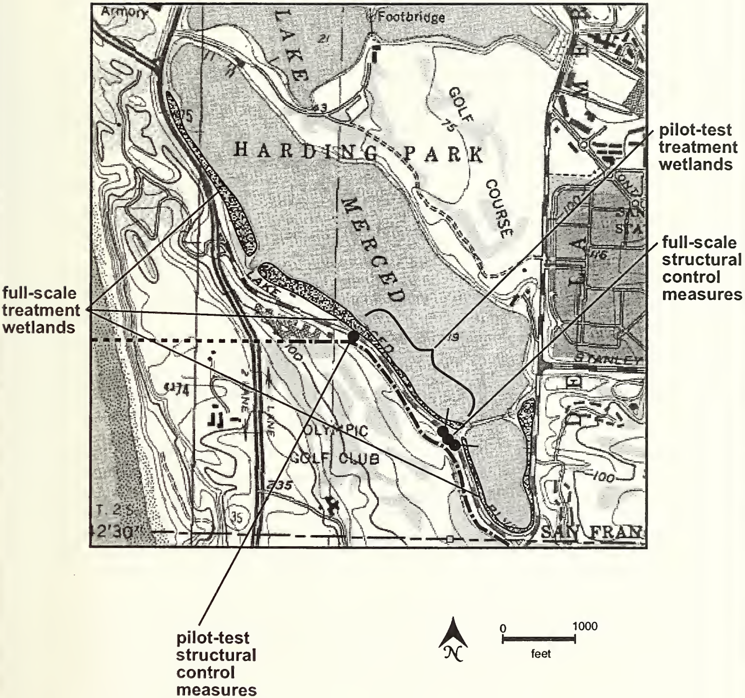


Figure 15
Proposed Facility Locations

data Daly City plans to identify the source and make immediate corrections to the system. Confirmatory sampling in the Vista Grande canal will then be implemented during the subsequent two to three rainfall events and then implementation of the pilot project will occur.

During the development of the preferred alternative, it was assumed that Daly City would be able to lower its coliform levels in Vista Grande canal to 20,000 MPN/100ml or lower. This level was estimated from the lower numbers observed during the 2000-2001 stormwater sampling. If Daly City is not able to lower its coliform levels to 20,000 MPN/100ml or lower, additional modifications to the preferred alternative will be necessary.

Assessment of Available Land

Facilities to be constructed for this project may include structural control mechanisms and treatment wetlands. The proposed location of these facilities are shown on Figure 15.

Structural Control Mechanisms

Up to four structural control units may be installed to treat and divert water to Lake Merced. Three of these are proposed for installation south of John Muir Boulevard on the approximately one acre of land just south of the viaduct. There appears to be enough land at this location to install the units, avoid the CCSF three-chambered sewer, and develop access for maintenance vehicles. The fourth unit is proposed for installation where the former gate house was located. This unit would be used for pilot testing and subsequent full-scale development.

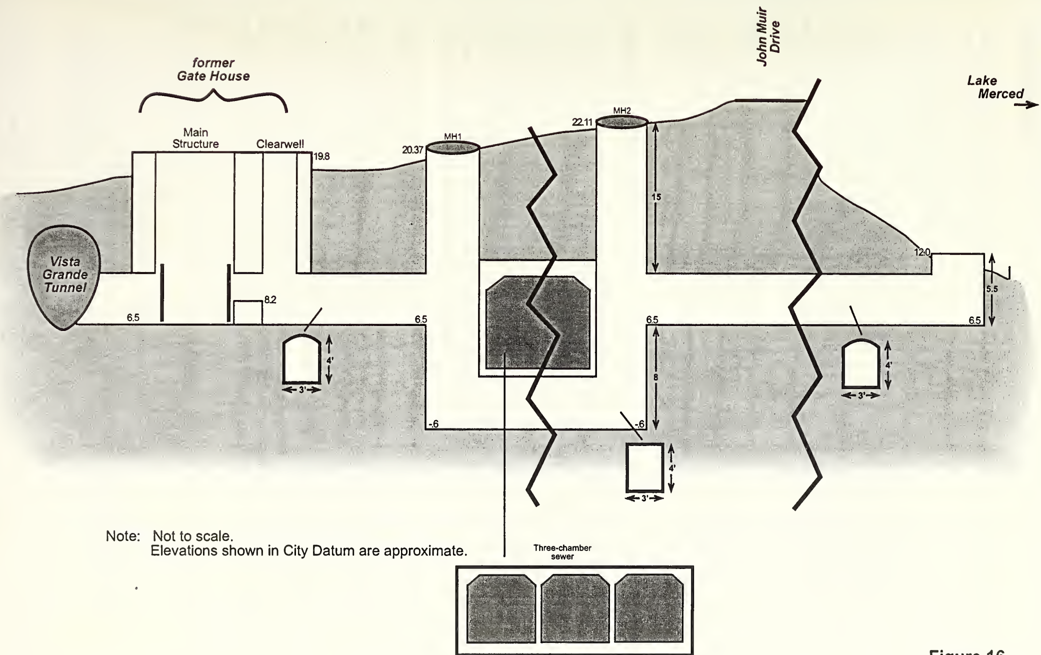
Treatment Wetlands

Land available for treatment wetland development was assessed by first identifying what general areas of Lake Merced could support development of treatment wetlands. The two primary criteria were that Vista Grande water had to be conveyable to the area and that the slope of the land was minimal. The two main areas that met these criteria were the south shore of South Lake and the entire shoreline of Impound Lake. The total acreage of the area that meet these criteria was estimated to be 23 acres.

There are two factors that could limit development of the entire specified area. First, a sighting of a California Red-legged frog (a Federally-listed threatened species) was made in the Impound Lake area in 1999. Although enhancement of wetlands along the shore of Impound Lake could improve the habitat for the red-legged frog, there would need to be extensive biologic review and coordination with the San Francisco Recreation and Park Department (which manages the shoreline of Lake Merced) and other involved groups. The second factor that could limit treatment wetland development is the area of lead-impacted soil at the Pacific Rod and Gun Club. Although available data (Ecology and Environment, 1993) indicate that most of the lead-impacted soil is limited to the top foot of soil, soil remediation would probably be needed prior to wetlands development.

Conveyance Mechanisms

Moving water from the canal to the lake will require construction of two lines under John Daly Boulevard and/or the CCSF three-chambered sewer. The existing Lake Merced



Note: Not to scale.
Elevations shown in City Datum are approximate.

Figure 16
Schematic Cross-Section of
Lake Merced Overflow Structure

V082001007SAC exhibit004-fig14_Schem_Cross-Section.fh9

Overflow structure will be used during the pilot test and is proposed to remain operational during full-scale implementation.

Lake Merced Overflow Structure

The Lake Merced overflow structure (Figure 16) was constructed to convey water from Lake Merced to the Vista Grande tunnel. The overall gradient of the overflow structure is slightly towards the tunnel. The overflow structure was later modified when the three-chambered sewer was installed by the CCSF. The existing Lake Merced overflow structure is planned to be used during Phase II pilot testing and full-scale implementation. The outflow from the structural control unit would be introduced to the overflow structure at a point lakeside of the 'main structure' (see Attachment A, page A-3).

Additional Conveyance Lines Under John Muir Boulevard

Two additional conveyance lines will be constructed from the structural control mechanisms to South and Impound Lakes, as shown in Figure 15. One line will convey water from the structural control units to South Lake. The other line will go to Impound Lake.

Structural Control Units

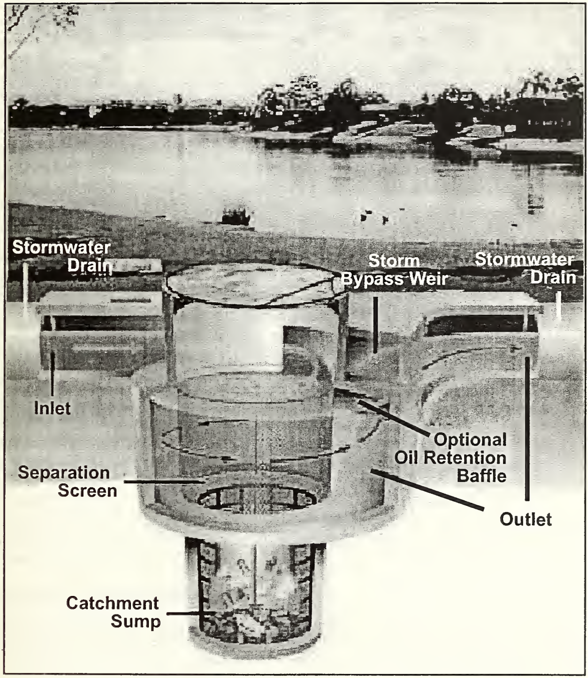
Structural control units such as those manufactured by CDS, are planned for installation as an initial water quality treatment process. CDS units (Figure 17) use a non-blocking screen in combination with vortex hydraulics to separate pollutants such as floatables, particles, suspended solids, and oil and grease form the effluent storm water. They are non-mechanical systems that are completely gravity-driven and do not have moving parts. Pollutants settle to a sump, floatables remain in the separation chamber, and water and particles smaller than the screen size flow to the outlet. Although CDS units are not used primarily for coliform removal, they provide some coliform reduction by removing coliform attached to the separated solids and particulates.

Development of Treatment Wetlands

A conceptual design for full-scale development of treatment wetlands along the existing shoreline of Lake Merced was developed assuming that the majority of the south shore of South Lake and the entire shoreline of Impound Lake will be used. Based on the existing topography a total of 23 acres is potentially available for use as treatment wetlands. Because of the nature of the land available, the wetlands would be divided into several stand alone micro-basin wetlands which would receive an area-based proportionate flow from Vista Grande Canal. Additional optimization for improved hydraulic and water quality performance will occur after pilot test completion and during full-scale design to optimize area-based treatment requirements

The main design features and criteria of this conceptual design were based on the project objectives and include:

- Treatment wetland cell sufficiently sized to produce meaningful performance results
- Treatment performance could evaluate multiple hydraulic loading rates to evaluate potential differing water quality criteria and to maximize the collection performance data in a short time frame



from CDS Technologies,
a manufacturer of
structural control measures

Figure 17
Schematic View of a
structural control measure

- Evaluation of other ancillary benefits such as habitat enhancement for wildlife and waterfowl usage

These micro-basin wetlands are created by constructing a berm on the lakeside portion of the wetland of sufficient size to maintain wetland integrity and a necessary treatment area. A typical micro-basin wetland configuration incorporates the natural shape of the shoreline as the wetlands length and will be approximately 50 to 100 feet wide depending on the shoreline configuration and topography (Figure 18).

The conceptual design allows for period peak flow from the Vista Grande that occurs during significant rainfall events. Water conveyance consist of passive flow from existing sources and include the Vista Grande Canal and Tunnel and other for baseflow necessary to sustain the wetlands.

Treatment wetlands will include both deep zones and shallow zones for emergent plant propagation. Design depths will be 4 - 5 feet (ft) for deep-water zones and 0.5 – 2 ft for shallow zones. Deep zones will be created surrounding the inflow and outflow structures in order to distribute flow, increase hydraulic residence time, allow for settling of particulate matter, and create a greater diversity of habitats. A deep-water zone and habitat islands will also be created in the middle of the treatment wetland. The target ratio of shallow to deep zones for these treatment wetlands is 80:20 as a percentage of available area.

Surface flow treatment wetlands function as land-intensive biological treatment systems. Inflow water containing particulate and dissolved pollutants spreads through a large area of shallow water and emergent vegetation. Particulates (TSS) tend to settle and are trapped due to low flow velocities and sheltering from wind. These particulates contain BOD components, fixed forms of total nitrogen (TN) and total phosphorus (TP), and trace levels of metals and organics. These insoluble pollutants enter into the biogeochemical element cycles within the water column and surface soils of the wetland. At the same time, a fraction of the dissolved BOD, TN, TP, and trace elements are sorbed by soils and active microbial and plant populations throughout the wetland environment. These dissolved elements also enter the overall mineral cycles of the wetland ecosystem.

Wetland Water Quality Performance

Modeling of treatment wetland water quality was conducted based on the conceptual design presented in the previous section. The purpose of this modeling was to evaluate:

- The anticipated water quality improvements based on the conceptual design and total area available (23 acres)
- The potential need for a combination of technologies to meet discharge water quality objectives

Water quality modeling was conducted based on the following assumptions:

- Water quality discharge target concentrations would be based on Lake Merced background concentrations (no net degradation in Lake Merced water quality) or guidelines established in consultation with the RWQCB.
- Average water quality concentrations from Vista Grande were used as treatment wetland influent concentrations

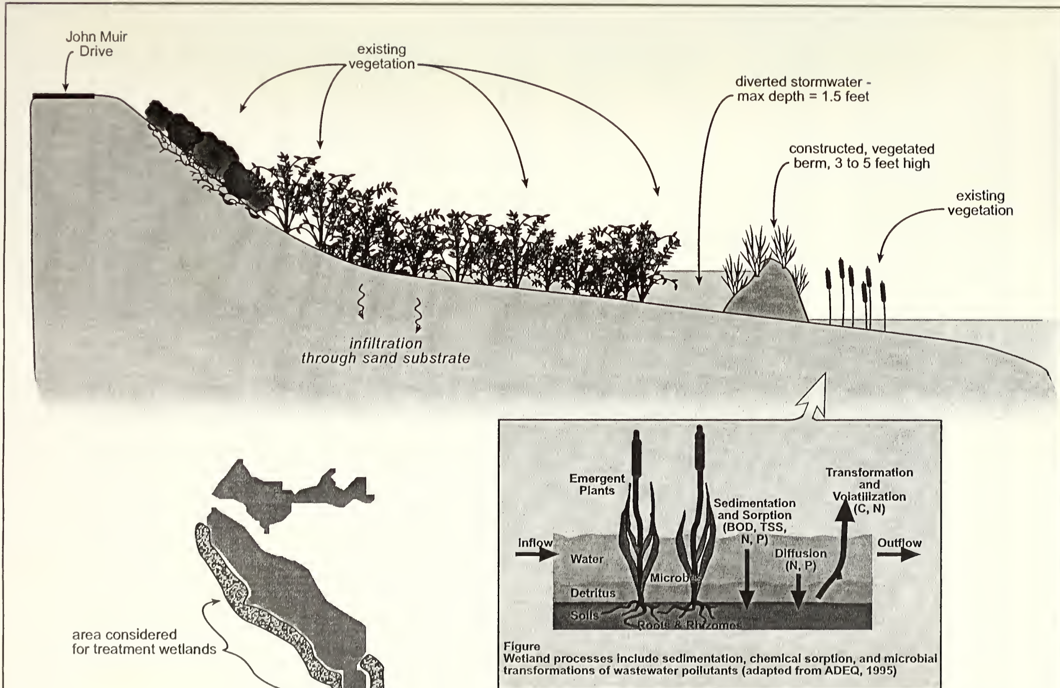


Figure
Wetland processes include sedimentation, chemical sorption, and microbial transformations of wastewater pollutants (adapted from ADEQ, 1995)

Figure 18
Proposed Approach
to Treatment Wetlands

W0820010079AC exhibit003-Proposed_Approach

- The first order area-based model developed by Kadlec and Knight (1996) was used to estimate water quality improvements in the treatment wetland (Attachment B provides background to the modeling)

Target water quality concentrations in wetland discharge are presented in Table 14. These represent Lake Merced background concentrations or in the absence of sufficient data, typical water quality concentrations based on other California water quality guidelines. The target for total coliforms was estimated due to the nature of the available data which reported several greater than maximum concentrations (>2,419 MPN/100ml).

TABLE 14
Wetlands Evaluation Target Water Quality Goals[a]
Vista Grande Diversion Feasibility Study

	Initial Concentration (mg/L)			Post Wetland Wetland Treatment Concentration[b] (mg/L)	
Parameter	**Inflow**	**Lake**	**Target**	**Post-Treatment**	**Percent Reduction**
BOD	25	---	30	16	36
COD	75	---	50	45	40
TSS	50	---	25	25	50
TOC	30	---	10	10	67
Oil and Grease	20	1.3	5	5	75
Total Coliform	10,000	1,060	2,000	3000	70
	5,000	1,060	2,000	1,300	75
	2,500	1,060	2,000	800	70

[a] Average stormwater duration of 4 hours at 36 cfs.

[b] Hydraulic loading rate is 15.8 cm/d and residence time is 2.4 days.

The model parameters (TOC, oil and grease, BOD, TSS, and total coliforms) estimated using the k-C* model are summarized in Attachment B. Treatment performance modeling results using the k-C* model are shown for a number of design flow rates including 5, 10, 15, 25 and 30 cubic feet per second (cfs). The modeling was conducted to determine design flow rates for these fixed-area treatment wetlands of a total of 23 acres. Modeling was conducted using the design discharge criteria shown above using average influent concentrations based on available water quality from Vista Grande.

Results of the first-order modeling are shown graphically in Figure 19. As indicated in Figure 19, water quality concentrations increase with increasing flow rate. Some parameters increase at greater rates which is a function of the area-based treatment performance inherent with treatment wetlands and the water quality parameter. With the treatment wetland area fixed at 23 acres, water quality targets can be met at the targeted flow rate.

Reasonably significant reductions in parameter concentrations were noted for BOD (36 % reduction), COD (40 % reduction), TSS (50 % reduction), TOC (67% reduction), and oil and grease (75 % reduction). Total coliforms reduction (70 %) was considerable and does follow the same decay rate as other parameters as indicated in Table 15. However, it is predicted

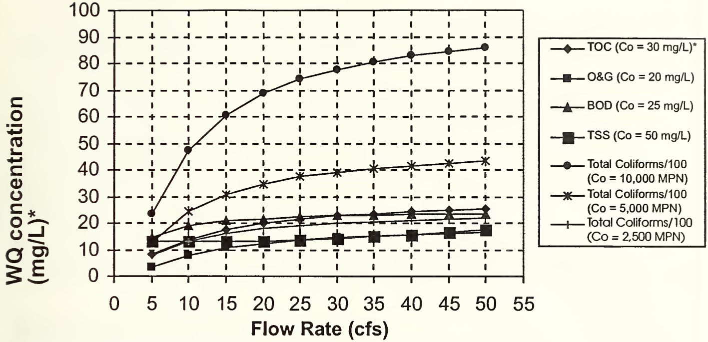


Figure 19a. Predicted water quality concentration as a function of flow rate - proposed Lake Merced treatment wetlands*
Co = initial concentration = average concentration in Vista Grande channel

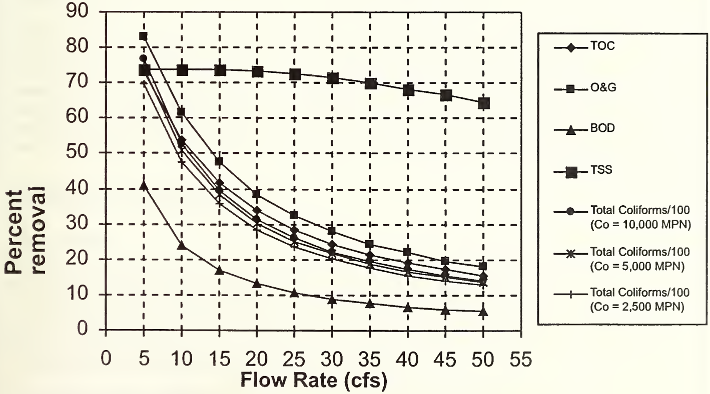


Figure 19b. Predicted water quality parameter percent removal versus flow rate - proposed Lake Merced treatment wetlands
* Co = initial concentration = average concentration in Vista Grande channel

Figure 19
Estimated Treatment Wetlands Water Quality Benefits

W082001007SAC exhibit006-WQVersusFlow.fh9

that if the initial concentration of 10,000 MPN, there is insufficient area to treat to target levels. Initial concentrations of 5,000 or 2,500 MPN are predicted to be treated to 1,300 and 800 MPN at the proposed flow rate.

Additional modeling was conducted to evaluate an increase in wetland area to 30 acres and a flow rate at 6 cfs in the event more acreage was available for treatment wetlands. Results show similar trends to the 23 acre wetlands with further reductions in most water quality parameters. At 30 acres and a flow rate of 6 cfs total coliform reduction is approximately 80% (10,000 to 2,000 MPN) to the target concentration of 2,000 MPN. These values are fairly typical based on the performance of functional wetlands. Attachment B provides additional performance data from other wetlands in the United States.

Other important parameters that were not included in this preliminary performance modeling (due to lack of or limited data) which may affect water quality performance and ultimately treatment wetland sizing include total phosphorus, and nitrogen compounds.

Assessment of Project Flow Rates

The two limiting factors in this approach are the area available for development of treatment wetlands and the ability of the lake to receive water. As discussed in the previous section, the limits of the proposed 23 acres of treatment wetlands to bring coliform levels of 10,000 down to 1,500 MPN/100 ml is approximately 6 cfs. The second limiting factor is how much water Lake Merced can receive during a storm event.

Flow is assumed to be conveyed to both South and Impound Lakes. Because of concerns over the structural integrity of the viaduct and additional permitting requirements associated with constructing a direct connection between South and Impound Lakes, proposed flow to the lakes would be maintained separately. In the assessment of how much water could be added to Lake Merced during a single storm event, it is assumed that the 6-inch criteria currently in place with the CCSF Catagorical Exemption (see footnote 6) will be maintained. Assuming that all water introduced into the lake remains in the lake[23]

Regulatory Constraints

Background

The area surrounding Lake Merced provides important habitat values to dependent plants and wildlife species. Birds are the predominant wildlife species, although numerous amphibians, reptiles and mammals also inhabit the wildlife habitats of the Lake. Several species of birds nest around the Lake perimeter: bird nests are protected under the federal Migratory Bird Treaty Act and California Fish and Game Code, and should be protected while the nests are active (i.e., contain eggs or nestlings).

The proposed pilot project to raise water levels at the Lake could affect the quantity or quality of vegetation, or could result in changes to the duration, timing, or amount of flow of water to the Lake. These modifications could result in impacts (either beneficial or

[23] Previous evaluation of the Lake Merced historic hydrographs show that water added to Lake Merced will 'leak out' into the surrounding aquifer over time.

adverse) on biological resources, and may require a permit or approval from the U.S. Army Corps of Engineers (pursuant to Section 404 of the Clean Water Act), the Regional Water Quality Control Board (pursuant to Section 401 of the Clean Water Act), or from the California Department of Fish and Game (pursuant to state Fish and Game Codes, including Section 1600 et. seq.: Stream and Lakebed Alteration).

Potential Project Impacts

The proposed project may have environmental impacts during construction and planting of the wetland area and berm, and during the gradual and seasonal lake level increases during operation of the project.

A survey was conducted in 1988[24] that delineated the soil, vegetation and wildlife conditions at the lake. Sensitive plant species were not observed, but are potentially present in the area. [25] There are several invasive exotic plants at many locations around the lake. [26] Wetland vegetation is present at the lake edge. Special-status wildlife species are potentially present at Lake Merced.

Common wildlife that may be affected during construction of the project would be protected under the state Department of Fish and Game Code relating to harvest, confinement, destruction, importation, transportation and possession restrictions (California Code of Regulations, Title 14, Natural Resources, Sections 2189 to 2192 and 671, dated August 1, 1999). The project will likely require a Section 1600 Streambed Alteration Permit from the California Department of Fish and Game and common wildlife would be protected under that permit.

Lake water levels have been raised in the past through the addition of pumped, dechlorinated water. The quantity of add water was defined as follows: prior to February 15 and after July 15, lake levels were not allowed to increase more than one foot over the water elevation existing as of July 15; from February 15 to April 15, the lake water level was not allowed to increase more than six inches above the water elevation existing as of February 15; and from April 15 to July 15 no water was allowed to be added to the Lake. Based on a review by the California Department of Fish and Game and the Golden Gate Audubon Society, slowly adding water to Lake Merced during the above time periods would not impact the recognized special status species or their habitat.

Permitting Constraints

The project would require clearance under the California Environmental Equality Act (CEQA), as it would involve construction and construction-related activities, clearing and land grading, as well as some maintenance activities. The previous additions of water were considered categorically exempt from CEQA, since no modifications were made to the Lake edge or infrastructure.

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[24] Camp, Dresser & McKee, Inc and Trihey & Associates, Inc., Lake Merced 1998 Baseline Natural Resources Inventory, April 1999.

[25] California Natural Diversity Database, San Francisco lessingia, San Francisco Bay spineflower, Kellogg's horkelia, San Francisco owl's clover.

[26] Iceplant, cape ivy and tamarisk were identified.

Informal interviews with the regulatory agencies will need to be conducted after the project description is finalized to determine the agency jurisdiction and the extent of the permit requirements. The proposed gradual and seasonal increase in Lake water levels and the associated submerging of vegetation and habitat would be evaluated by the regulatory agencies in the context of normal (without the project) fluctuations.

The Regional Water Quality Control Board has initiated a program to distinguish impaired water bodies. The water quality summaries for data from Lake Merced have evaluated by the RWQCB and staff has recommended (August 2001) Lake Merced be placed on a Preliminary List of Impaired Water Bodies, which would trigger additional water quality sampling on a more frequent schedule. Staff concerns are evidence of impairment in the dissolved oxygen and pH of the lake water. The list and the rationale for the RWQCB to determine impairment will be subject to a 45-day public review period, which commenced on August 28. RWQCB staff will respond to comments and will forward draft recommendations to the State Water Board by April 2002. Lake Merced will not remain on the Preliminary List for more than one cycle, or two to four years. It will either transition off the list, if sampling indicated favorable improvements, or will be placed on the List of Impaired Water Bodies. Placement on the list triggers total maximum daily load (TMDL), as required by the Clean Water Act, using available technology.

In addition, as previously noted, it is assumed that the coliform source will be significantly reduced in the canal water, either prior to or during implementation of the pilot project. The RWQCB is sensitive to the ultimate water quality and beneficial uses of the Lake and would not likely permit a project with source water containing high levels of coliform.

The extent of the project limits with respect to the U.S. Army Corps of Engineers (Corps) jurisdiction over water of the United States would need to be mapped according to the criteria outlined in 1987 Corps manual. From the 1998 Lake Merced Baseline Inventory (CDM, 1998), the proposed pilot project wetland area would be located in jurisdictional waters. Although the project would be considered beneficial to the overall lake water quality, compensation or mitigation would be required because of the loss of jurisdictional waters (the berm and the inundated area behind the berm). The ratio of compensation would be negotiated during the permitting process. The Corps is currently experiencing personnel shortages and the permit processing time may be at least 6 months.

Pilot Testing of Preferred Alternative

Proposed Approach

Pilot testing of the preferred alternative will be conducted in two phases. Phase I consists of testing the effectiveness of the structural control unit. If testing of the structural control unit proves to be effective, Phase II of the pilot test entails conducting a small-scale release to Lake Merced using the existing Lake Merced overflow structure to evaluate shoreline infiltration rates and additional water quality improvement associated with the existing shoreline plants.

Pilot Test Phase I

Phase I involves preliminary work by Daly City to identify and correct stormwater system shortcomings to reduce the coliform levels in the canal to those comparable to the lower end of the range observed during the 2000-2001 sampling (Tables 4 and 14). Figure 20 summarizes the planned activities and schedule for Phase I.

Construction

Several construction activities will occur during the fall of 2001. These include:

- Installation of the structural control unit (such as a CDS unit) in a new manhole to be located between existing Manhole #2 and Manhole #3 (see Attachment A, page A-3)
- Construction of a new diversion channel from the canal to the structural control unit
- Installation of an outflow line to return outflow to the canal during Phase I and to Manhole #1 during Phase II
- Improvement of the access road to the pilot test area to facilitate unit cleanout and water quality sampling

Concurrently with Daly City's work on identifying and correcting the system problems, a 19 cfs structural control unit will be installed in a new 9′-6″ OD manhole to test the effectiveness of treating diversion flows from the Vista Grande canal. For Phase I, diversion flows from the Vista Grande canal will be treated and returned to the canal. Influent to and effluent from the unit, as well as material retained in the unit will be monitored at a variety of flows for a number of constituents to determine design parameters and system effectiveness for the constituents of concern.

A 19 cfs can be surcharged up to 27 cfs; thus a wide range of flows may be studied, including surcharged conditions and the resulting impact on the water quality discharged from the unit. Additionally, the unit may continue to be used after the pilot test is concluded.

A new diversion channel will be constructed to divert excess stormwater from the Vista Grande canal to the CDS unit. The diversion weir will be located at a level in the canal

		2001			2002			
		O	N	D	J	F	M	A
Coliform Source	Conduct sampling during initial rainfall events to identify area of problem		■	■				
	Correct system conditions			■				
	Conduct confirmatory Vista Grande sampling to confirm correction and identify anticipated future canal coliform levels			■	■	■		
Pilot Testing	Conduct design of stormwater treatment pilot test system	■						
	Obtain construction contractor	■	■					
	Install stormwater treatment pilot test system		■	■				
	Conduct treatment pilot test water quality sampling			■	■	■		
	Determine feasibility of phase II implementation					■		
	Draft documentation complete							■
Regulatory Coordination	Meet with SFRWQCB to discuss upcoming pilot test		■					
	Provide feedback to the SFRWQCB regarding the proposed Impaired Waterbody designation	■						
	Obtain from SFRWQCB agreement on target water quality goals for Lake Merced		■	■				
	Begin permitting process for development of natural treatment wetlands at Lake Merced					■		
	Report pilot testing results to SFRWQCB						■	

Figure 20
Pilot Test
Phase I
Implementation Schedule

to enable the system to be gravity-fed during moderate to high flow events. Treated water will be returned to the canal for the duration of Phase I of the pilot study to ensure that Lake Merced water quality is not impacted.

Coordination with the CCSF is required for implementation of this effort because all construction activities will occur on land owned by CCSF. No permits are required other than those that may be required by CCSF.

Monitoring

The monitoring program to be implemented during the testing of the CDS unit will be similar to that recommended by the manufacturer. The Mass Balance Approach monitors influent, effluent, suspended solids, and the material retained in the unit. It is more labor-intensive that automatic samplers commonly used in stormwater monitoring, but the manufacturer considers this approach to provide more representative data.

Pilot Test Phase II

If the water quality data from Phase I indicates that the coliform levels in the outflow from the CDS units is in the range of 1,500 MPN/100 ml, then after coordination with the SFRWQCB a small-scale test of diversion to the lake will be conducted. The initial test is proposed to be approximately 10 cfs for 1 to 2 hours. Modification of the overflow structure will be required, including removing the existing 'chimney' and introducing flow attenuation devices. Although a treatment wetland constructed berm will not be in place to direct outflow (because of the extended permitting required for berm installation), a small-scale diversion will provide information regarding infiltration rates and preliminary information to planning larger-scale development of treatment wetlands. Infiltration rates along the shoreline and water quality changes as the water migrates towards the lake and enters the lake will be quantifies during Phase II pilot testing.

Preliminary Cost Estimate

The preliminary cost estimate for construction and implementation of the pilot testing is summarized in Table 15.

TABLE 15
Pilot Test Preliminary Cost Estimate
Vista Grande Diversion Feasibility Study

Activity	Low Estimate	High Estimate
Design of Pilot Project Facilities	$40,000	$75,000
Purchase and Installation of CDS unit	$ 175,000	$ 250,000
Construction of Diversion Structure and Access Area	$50,000	$75,000
Monitoring Program	$50,000	$75,000
Coordination with Regulatory Agencies and Permitting	$ 5,000	$ 50,000
Project Documentation	$ 15,000	$ 30,000

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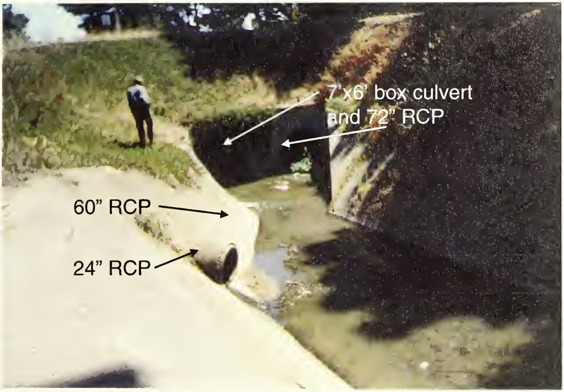
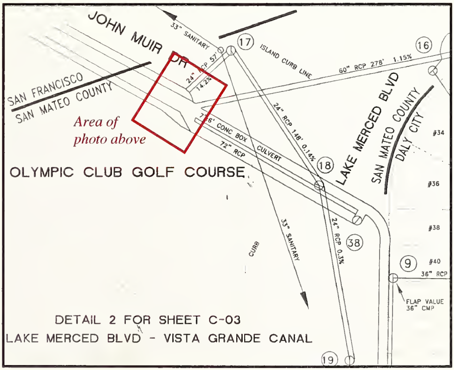
Attachment A
Project Photos

Improved (widened) area of Vista Grande canal, just downstream of Daly City Blvd. Ramps were constructed to facilitate canal cleaning.

Vista Grande canal just upstream of the tunnel. This is the size of the majority of the canal.

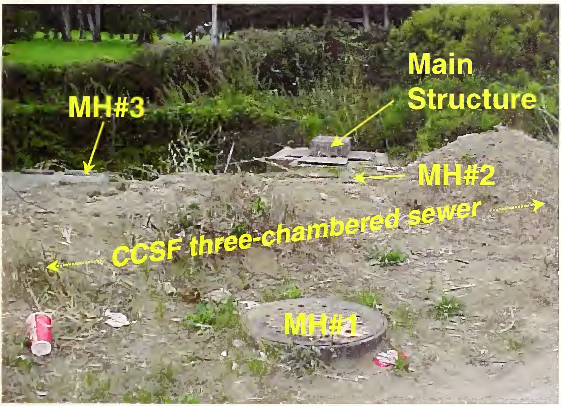


Beginning of Vista Grande Canal, just west of Lake Merced Blvd.



Daly City engineering diagram showing storm sewer lines entering Vista Grande canal.

General area near the former gate house.



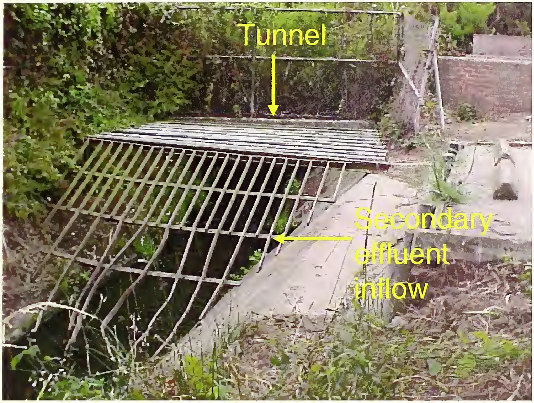
At edge of John Muir Drive looking towards the former gate house.

"Clearwell" on north side of the main structure of the former gatehouse.

Main structure of the former gatehouse. Sluice gates are closed. Pipe in center of picture is a vacuum truck line.

Overflow structure outfall along the shore of Lake Merced.

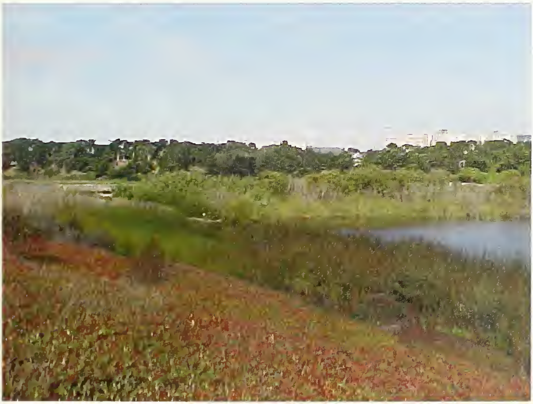
Outfall of Lake Merced overflow structure.



Bar screen at opening of Vista Grande tunnel.

Viaduct for CCSF three-chambered sewer along South Lake beach.

Vegetation along south shore of South Lake, looking north.



Vegetation along south shore of Impound Lake, looking towards the viaduct.

Site of 2001 overflow over John Muir Drive.

Shoreline impact resulting from 2001 overflow.

Attachment B
Additional Treatment Wetlands Information

Attachment B

Additional Treatment Wetlands Information

Wetlands Performance Modeling

Water quality constituent attenuation rates can be estimated using a first-order exponential decay model (k-C* model). This is estimated by the use of inflow/outflow concentrations and hydraulic loading data. An area-based model is more appropriate than the conventional volumetric first-order models typically used for design of conventional wastewater treatment plants and ponds as wetland performance is tied closely to surface area rather than to water volume (Kadlec and Knight 1996). A plug-flow hydraulic assumption is most often used in wetland model calibration.

Wetland modeling was performed using the first-order area-based plug flow model developed by Kadlec and Knight (1996). This modeling estimates the potential performance of the wetland alternative for Lake Merced.

The simplest expression of the first-order, area-based plug flow wetland performance model, assuming no net rainfall or seepage, is:

$$\ln (C_1/C_2) = k_1/q$$

where:

C_1 = average inlet concentration, mg/L

C_2 = average outlet concentration, mg/L

k_1 = first-order, area-based rate constant

q = average hydraulic loading rate, m/yr

This is the general form of the wetland model and can be referred to as the one-parameter or k_1 model.

Data from many treatment wetlands indicate that internal and external loading of pollutants such as BOD, TSS, TN, and TP may result in non-zero, irreducible wetland water column constituent concentrations. For some purposes these concentrations may be so low that they are indistinguishable from zero. In other cases, effluent discharge goals approach the lowest constituent concentrations measured in natural wetlands. In these situations, the plug flow model can be corrected by introducing a second parameter that represents the lowest achievable or irreducible concentration that will occur in a treatment wetland, C*. The two-parameter first-order, area-based plug flow model, or k-C* model, is:

$$\ln[(C_1-C^*)/(C_2-C^*)] = k/q$$

Inlet and outlet concentration data can be used with the average hydraulic loading rate, q, to estimate k and C* for a given treatment wetland data set. Average data over a period of time greater than the average hydraulic residence time in the wetland should be used when

making these parameter estimates. These parameters are most often calculated based on monthly, quarterly, or annual average data sets.

Treatment Performance at Other Treatment Wetlands

The use of wetlands for wastewater treatment is an emerging technology in North America and worldwide. These wetland systems have a wide variety of engineering designs, wetted areas, flow rates, inflow water qualities, plant communities, hydrologic regimes, effluent limitations, and monitoring requirements. However, treatment wetlands receiving a variety of different wastewater types respond in a similar and predictable fashion. Treatment wetland performance for 154 municipal wastewater streams, as well as systems designed for many other purposes, is described in the North American Wetland Database (NADB, 1995). Treatment wetlands decrease concentrations of BOD, TSS, nutrients, metals, pathogens, and trace organics. Wetland treatment efficiency depends upon inflow concentration and mass loading. Treatment efficiencies decline to zero as concentrations of chemical constituents in the water approach background concentrations. Treatment wetland efficiency for several key water quality parameters is presented in Table B-1.

TABLE B-1
Summary of North American Wetland Treatment System Performance

Parameter	Concentration (mg/l)		Removal Efficiency
	In	Out	
BOD_5	30.3	8.0	74%
TSS	45.6	13.5	70%
Total Coliforms	1,150,000	24,000	97.9%
Fecal Coliforms	25,800	473	98.2%

From Kadlec and Knight (1996)

Treatment wetlands used in a variety of treatment systems improve water quality and enhance wildlife. The Columbia, Missouri Regional Wastewater Treatment Plant uses 100 acres of surface flow treatment wetlands as a final polishing step to decrease BOD and TSS for 15 mgd of its secondary treatment plant effluent. The treatment wetland is significantly improving water quality (Table B-2). The marsh-polished water is subsequently used in the nearby Eagle Bluffs Wildlife Area to improve 1,200 acres of natural wetlands. The treatment wetland is being expanded from 100 to 140 acres to accommodate a treatment volume of 20 mgd (Mr. Joel Gamble, Supervisor, Constructed Wetlands Treatment Project, Columbia Regional WWTP, personal communication).

TABLE B-2
Columbia, Missouri Regional WWTP Treatment Wetland Design and Performance Data

Parameter	Design Effluent Water Quality		Actual Effluent Water Quality	
	Plant	Marsh	Plant	Marsh
BOD	50 mg/l	30 mg/l	20 mg/l	10 mg/l
TSS	45 mg/l	30 mg/l	20 mg/l	10 mg/l